United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Nodaway County, Missouri

How To Use This Soil Survey

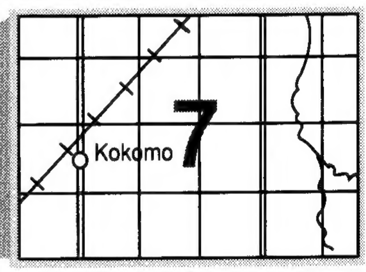
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

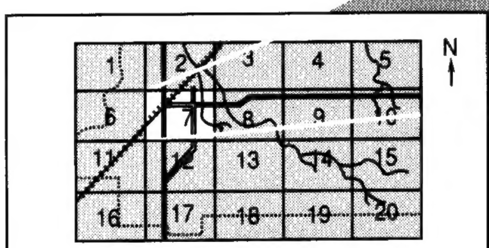
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



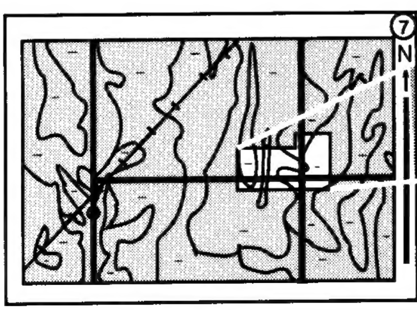
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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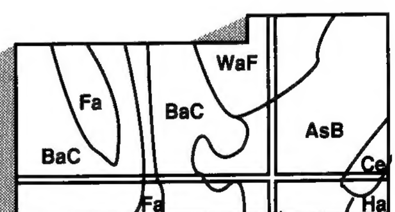

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Missouri Department of Natural Resources provided a soil scientist to assist with the fieldwork. The County Court, through the Comprehensive Employment and Training Act (CETA program), provided funds through the local Soil and Water Conservation District for a soil scientist to assist with the fieldwork. The survey is part of the technical assistance furnished to the Nodaway County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: An area of Sharpsburg silty clay loam, 2 to 5 percent slopes, used as cropland. Most areas of the Sharpsburg soils in Nodaway County are used for corn and soybeans.

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Soil Series

Issued June 1986

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Nodaway County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Nodaway County, Missouri

By Jerome L. Zimmerman, Soil Conservation Service

Fieldwork by Jerome L. Zimmerman, Carol A. Bartles, Richard D. Douglas, and Phill D. Gurley, Soil Conservation Service;
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United States Department of Agriculture,
Soil Conservation Service
In cooperation with
the Missouri Agricultural Experiment Station

Nodaway County is in northwest Missouri (fig. 1). It has an area of about 560,198 acres, or 875 square miles. It is bordered on the north by Page and Taylor Counties, Iowa; on the east by Worth and Gentry Counties; on the south by Andrew County; on the southwest by Holt County; and on the west by Atchison County. Maryville, the county seat, is in the central part of the county. In 1980, the population of the county was 21,996, and the population of Maryville was 9,558. Other towns in the county that have a population of 500 or more are Burlington Junction and Hopkins.

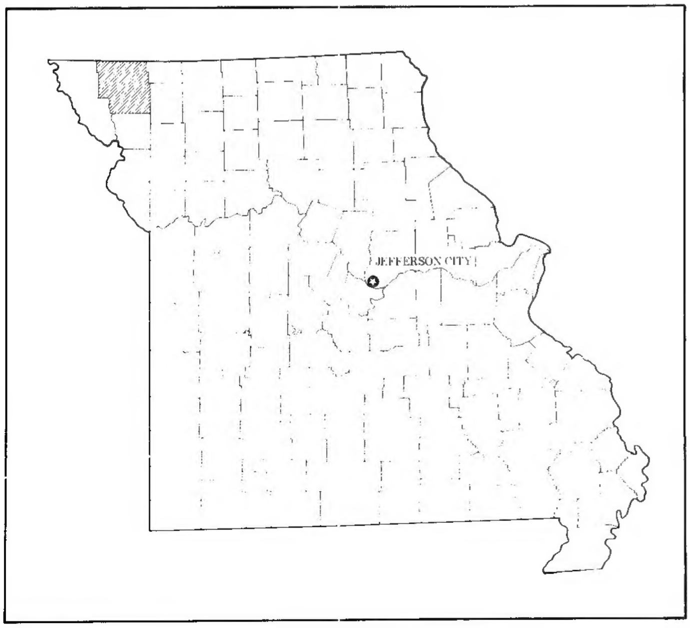

Figure 1.—Location of Nodaway County in Missouri.

Crop and livestock production are the major sources of farm income in Nodaway County. Factory products manufactured in and near the Maryville area are also important to the economy.

This survey updates the soil survey of Nodaway County published in 1915 (*16*). It provides additional information and larger maps, which show the soils in greater detail and define the soil boundaries more clearly.

General Nature of the County

This section gives general information concerning the county. It describes climate, natural resources, history and development, drainage and relief, and transportation facilities.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The consistent climatic pattern in Nodaway County is one of cold winters and long, hot summers. Heavy rains

occur mainly in the spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall normally is adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Maryville, Missouri, in the period 1951 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 25 degrees F, and the average daily minimum temperature is 14 degrees. The lowest temperature on record, which occurred at Maryville on January 13, 1974, is -32 degrees. In summer the average temperature is 73 degrees, and the average daily maximum temperature is 85 degrees. The highest recorded temperature, which occurred at Maryville on July 13, 1954, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 35 inches. Of this, 25 inches, or 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 4.68 inches at Maryville on June 21, 1952. Thunderstorms occur on about 53 days each year, and most occur in summer. Tornadoes and severe thunderstorms strike occasionally but are local in extent and of short duration. They can cause damage in scattered spots. Hailstorms occur at times during the warmer part of the year but in an irregular pattern and only in small areas.

The average seasonal snowfall is about 22 inches. The greatest snow depth at any one time during the period of record was 15 inches. On the average, 19 days during the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Natural Resources

Soil is the most important natural resource of Nodaway County. It supports marketable grain crops and is used for legumes and grasses for pasture and hay.

Ground water is available in varying quantities from the wells in the alluvium along major streams in the county. The occurrence of water from glacial deposits varies more than the occurrence of water from the alluvial deposits (*3*). Rural residents depend on rural water districts or ponds for their water supply.

Limestone is quarried and used as road material or concrete aggregate or is crushed and used for agricultural lime. Deposits of sand are along the three major rivers in the county.

History and Development

Several bands of Indians thrived in northwest Missouri. The Ioway, Pottawattomie, Sac, Fox, and Sioux Indians hunted abundant game on the land that is now Nodaway County and caught fish in its rivers.

Settlers longed to move to this territory when it was assigned to the Indians. The United States proposed the acquisition of Platte County in exchange for cash and land south of the Missouri River (*10*). A treaty was signed at Fort Leavenworth, and the Indians agreed to the terms on September 17, 1836. Nodaway County was a part of the Platte purchase.

Nodaway County was organized on February 14, 1845. After the Civil War, improved land sold for 20 to 25 dollars an acre and unimproved land sold for almost nothing (*7*). The railroad had a tremendous impact on the development of Nodaway County. In 1869 and 1870, the Burlington Railroad was built through the county. As a result, machinery, such as mowing machines, reapers, and the double shovel, became available to farmers, enabling them to farm more land. The railroad also provided transportation for more settlers and businessmen. By 1880, the population was 29,544. In that year, the county's farmers produced 7 million bushels of corn and more oats than any other county in the state. In addition they led the state in the production of livestock, raising 55,000 head of cattle, 86,000 hogs, and more horses than any other county in Missouri (*7*). As farming and business prospered, the population of the county increased until by 1900 it had reached 32,938.

From 1900 to 1950, the population declined slowly. In 1950, it was 24,033, and it has remained nearly the same since then. In 1981, it was an estimated 24,500.

Farming is still the largest industry in the county. Advancements in farming equipment, more productive breeds of livestock, superior varieties of grains, and conservation of the soil have kept the farming business profitable for those who are willing to change with the times and watch for economic warning signals.

Drainage and Relief

Nodaway County is mainly drained by three rivers—the

Nodaway, the One Hundred and Two, and the Platte. All three major rivers flow from north to south. Important smaller streams drain into them. The smaller streams—Mill, Clear, Elkhorn, White Cloud, Norvey, Mozingo, Long Branch, Honey, and Wildcat Creeks—generally flow to the south and are characterized by narrower flood plains and small stream terraces, or second bottoms.

The three major flood plains, which range from 1/4 mile wide to 2 miles wide, dissect the uplands into four units. On the loess-covered ridges and glacial till side slopes, several combinations of slope, parent material, soil material, thickness and drainage characteristics are apparent.

Elevation ranges from about 862 feet above sea level on the flood plain along the Nodaway River to 1,224 feet on the highest ridges in the northeastern part of the county.

Transportation Facilities

State Highway 71 crosses through the central part of Nodaway County from north to south. Branching off of State Highway 71 north of Maryville, State Highway 148 provides a northern route to the Iowa line. State Highway 136 passes through the central part of the county from east to west, sharing part of its route with State Highway 71 north of Maryville. State Highway 46 crosses through the central part of the county from east to west. It shares its route with State Highway 136 from Ravenwood to Maryville but extends westward to the Atchison County line. State Highway 246 crosses the northeastern part of the county, from Hopkins east to Worth County. State Highway 113 originates in the northwestern corner of the county at Burlington Junction and extends south to the county line. Many farm-to-market state and county roads are throughout the county.

Presently, two railroads serve Nodaway County. The county has two airports near Maryville.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example,

data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each association is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to

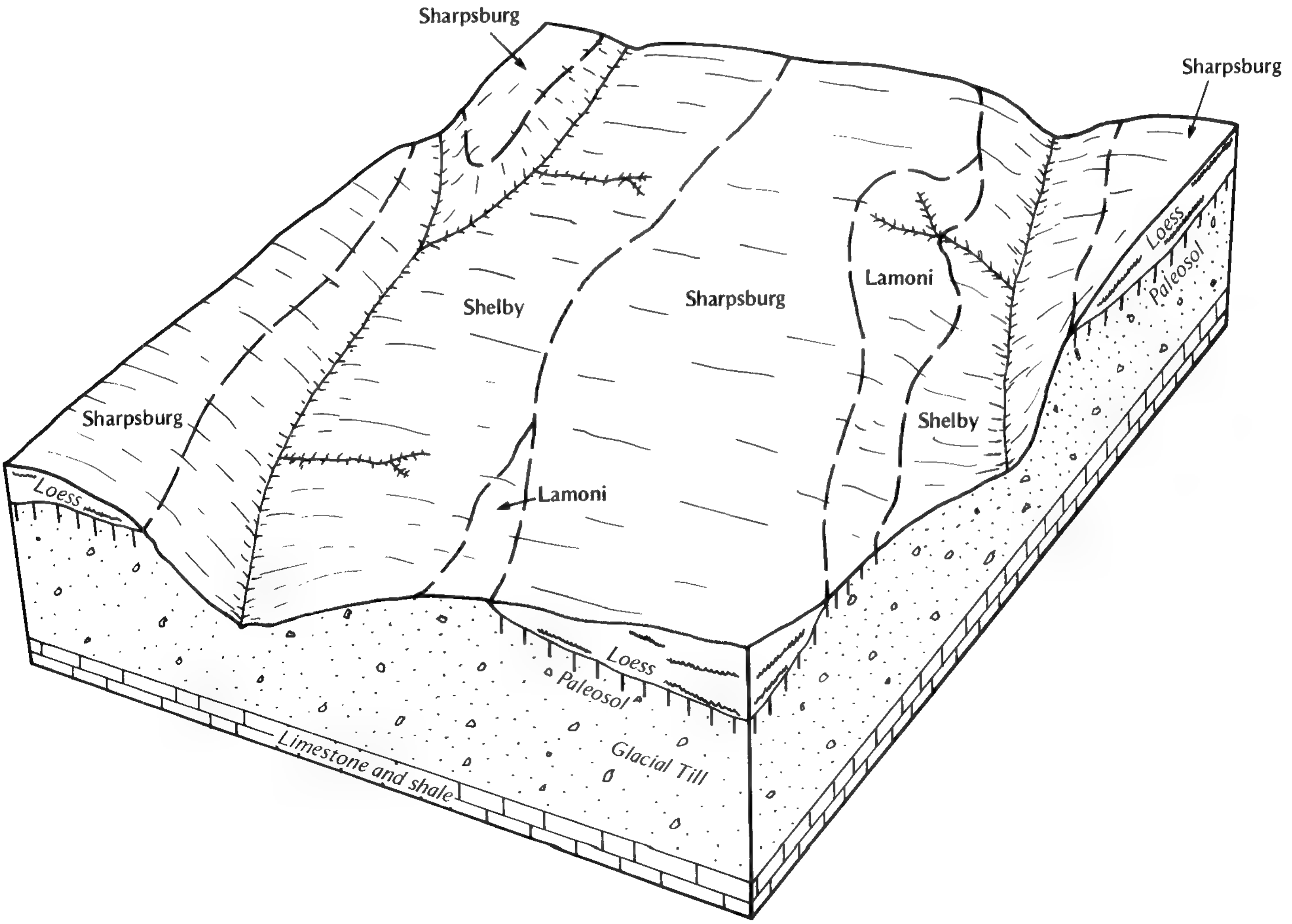

Figure 2.—Typical pattern of soils and parent material in the Sharpsburg-Shelby association.

place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils identified on the general soil map of this survey area do not fully agree with those in the surveys of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way was more practical than separating these soils and giving them different names.

Soil Descriptions

1. Sharpsburg-Shelby association

Gently sloping to moderately steep, moderately well drained soils formed in loess and glacial till; on uplands

This association consists of soils on narrow ridges dissected by branching narrow upland drainageways. The ridges generally are linear and lie in a north-south direction. Most areas are drained by secondary streams that flow to the south or west. Slopes range from 2 to 20 percent.

This association makes up about 9 percent of the survey area. It is about 47 percent Sharpsburg soils, 42 percent Shelby soils, and 11 percent minor soils (fig. 2).

The Sharpsburg soils are mainly on convex ridgetops and side slopes. Typically, the surface layer is black silty clay loam. The subsurface layer also is black silty clay loam. The subsoil is brown and dark yellowish brown silty clay loam. The substratum is yellowish brown silty clay loam.

The Shelby soils are mainly on side slopes. Typically, the surface layer is very dark brown loam. The subsurface layer is dark brown loam. The subsoil is dark yellowish brown and yellowish brown, mottled clay loam. The substratum is yellowish brown clay loam.

Minor soils in this association are the poorly drained Colo soils adjacent to drainageways and the somewhat poorly drained Higginsville, Lagonda, and Lamoni soils on side slopes and ridgetops at elevations between those of the Sharpsburg and Shelby soils.

This association is used mainly for cultivated crops, small grain, and grasses and legumes. Many of the steeper areas and the areas in the narrow upland drainageways are used for pasture or hay. Some of the moderately steep areas are idle, or they are used for woodland.

The moderately sloping and strongly sloping soils are suited to cultivated crops, small grain, and grasses and legumes. The main management concern is erosion control. Nearly all areas are suited to pasture or hay. The main concerns of pasture management are erosion control and the gully formation that results from overgrazing and grazing when the soils are wet. Ponds for livestock water have been constructed and generally are available in pastures that do not have flowing streams.

This association is suitable for sanitary facilities and building site development. The shrink-swell potential, the moderately slow permeability, and the slope are the main management concerns.

2. Shelby-Sharpsburg-Lamoni association

Gently sloping to moderately steep, moderately well drained and somewhat poorly drained soils formed in glacial till and loess; on uplands

This association consists of soils on narrow to relatively wide ridgetops and side slopes. The ridgetops vary in elevation and are somewhat dissected as their width decreases. Most areas are drained by small tributaries of the major rivers in the county. Streamflow is in a southerly direction. Slopes range from 2 to 20 percent.

This association makes up about 40 percent of the survey area. It is about 51 percent Shelby and similar soils, 22 percent Sharpsburg soils, 19 percent Lamoni and similar soils, and 8 percent minor soils (fig. 3).

The moderately well drained Shelby soils are mainly on the lower side slopes. Typically, the surface layer is very dark brown loam. The subsurface layer is dark brown loam. The subsoil is dark yellowish brown and yellowish brown, mottled clay loam. The substratum is yellowish brown clay loam.

The moderately well drained Sharpsburg soils are mainly on convex ridgetops and the upper side slopes. Typically, the surface layer is black silty clay loam. The subsurface layer also is black silty clay loam. The subsoil is brown and dark yellowish brown silty clay loam. The substratum is yellowish brown silty clay loam.

The somewhat poorly drained Lamoni soils are mainly on the upper side slopes and narrow ridgetops at elevations between those of the Sharpsburg and Shelby soils. Typically, the surface layer is black clay loam. The subsurface layer is very dark gray clay loam. The subsoil is olive brown and brown, mottled, firm clay in the upper part and mottled brown and gray, very firm clay in the lower part. The substratum is multicolored clay loam.

Minor soils in this association are the poorly drained Colo soils adjacent to drainageways and the somewhat poorly drained Higginsville soils on side slopes. Higginsville soils have less clay and sand than the Lamoni soils.

This association is used mostly for cultivated crops, small grain, and grasses and legumes. About 20 percent of the association is used for pasture and hay. Some areas on concave side slopes are used for pasture because of the seasonal wetness or seeps. A few of the steeper areas are used for woodland or are idle.

This association is suited to cultivated crops, small grain, and grasses and legumes. The main management

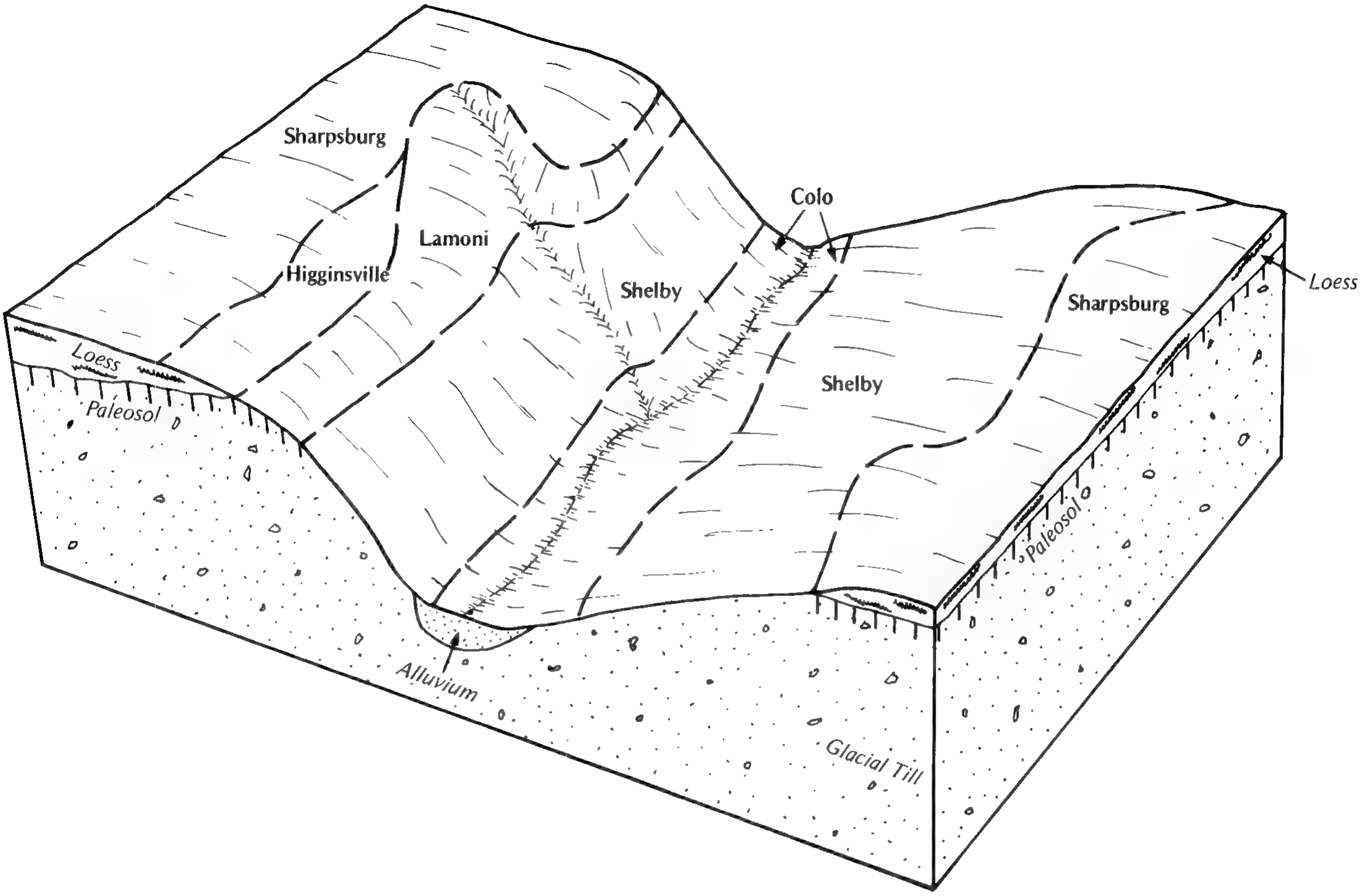

Figure 3.—Typical pattern of soils and parent material in the Shelby-Sharpsburg-Lamoni association.

concern is control of water erosion. The moderately steep areas are suited to grasses for hay and pasture. The main concerns of pasture management are erosion control and the gully formation that results from overgrazing or grazing when the soils are wet. Ponds generally provide supplemental water for livestock in pastures that do not have flowing streams.

This association is suitable for sanitary facilities and building site development. The slope, the shrink-swell potential, and the moderately slow permeability are the main limitations in areas of the Sharpsburg and Shelby soils. The slope, the slow permeability, the wetness, and the high shrink-swell potential are the main limitations in areas of the Lamoni soils.

3. Shelby-Lamoni association

Moderately sloping to moderately steep, moderately well drained and somewhat poorly drained soils formed in glacial till; on uplands

This association consists of soils on dissected side slopes and narrow ridgetops. The ridgetops are linear and are uniform in elevation. Most areas are drained by small streams that flow to the south or east. Slopes range from 5 to 20 percent.

This association makes up about 19 percent of the survey area. It is about 63 percent Shelby and similar soils, 26 percent Lamoni and similar soils, and 11 percent minor soils (fig. 4).

The moderately well drained Shelby soils are mainly on the lower side slopes. Typically, the surface layer is very dark brown loam. The subsurface layer is dark brown loam. The subsoil is dark yellowish brown and yellowish brown, mottled clay loam. The substratum is yellowish brown clay loam.

The somewhat poorly drained Lamoni soils are mainly on the upper side slopes and on narrow ridgetops. Typically, the surface layer is black clay loam. The subsurface layer is very dark gray clay loam. The subsoil is olive brown and brown, mottled, firm clay loam in the

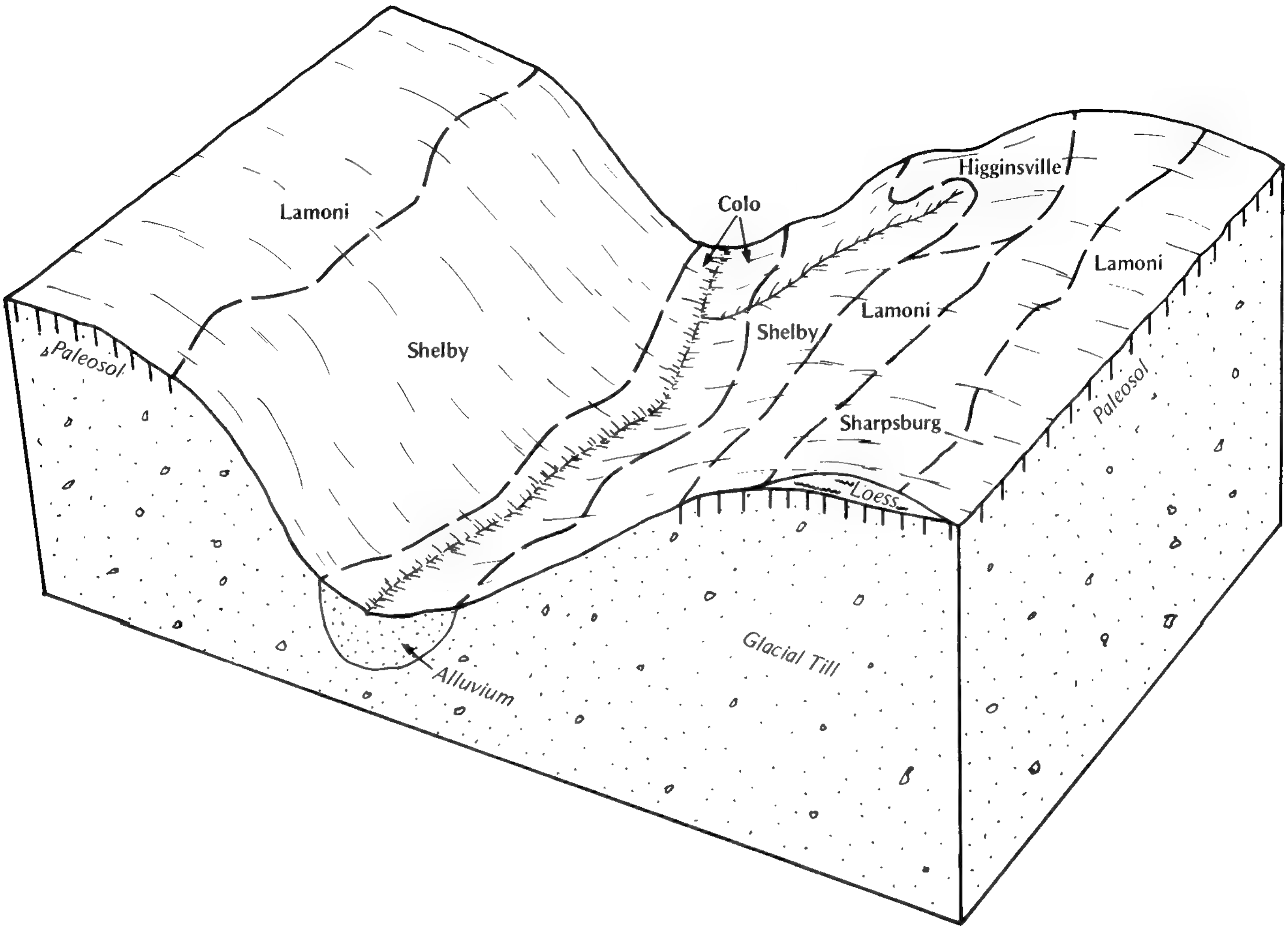

Figure 4.—Typical pattern of soils and parent material in the Shelby-Lamoni association.

upper part and mottled brown and gray, very firm clay in the lower part. The substratum is multicolored clay loam.

Minor soils in this association are the poorly drained Colo soils adjacent to drainageways, the somewhat poorly drained Higginsville soils on the upper side slopes, and Sharpsburg soils on ridgetops. The minor soils have less glacial sand and gravel than the Shelby and Lamoni soils and have less clay than the Lamoni soils.

This association is used mainly for cultivated crops, small grain, and grasses and legumes. About 40 percent of the association is used for pasture and hay. A few of the steeper areas are used for woodland or are idle.

The moderately sloping and strongly sloping soils are suited to cultivated crops, small grain, and grasses and legumes. Erosion control is the main management concern. The formation of gullies is a very serious concern. Nearly all areas are suited to grasses for hay and pasture. The main concerns of pasture management are erosion control and the gully formation that results from overgrazing or grazing when the soils are wet. Most areas have flowing streams that provide livestock water. Ponds for livestock water can be constructed, however, in pastures that do not have flowing streams.

This association is suitable for sanitary facilities and building site development. The main limitations are the slope, the shrink-swell potential, the slow permeability, and the wetness.

4. Sharpsburg-Higginsville-Nevin association

Nearly level to moderately sloping, moderately well drained and somewhat poorly drained soils formed in loess and silty alluvium; on uplands and stream terraces

This association consists of soils on upland ridgetops, side slopes, and stream terraces. Areas are parallel and

adjacent to the major flood plains. Nearly all are drained by the major streams. Slopes range from 0 to 9 percent.

This association makes up about 5 percent of the survey area. It is about 52 percent Sharpsburg soils, 21 percent Higginsville and similar soils, 18 percent Nevin and similar soils, and 9 percent minor soils.

The moderately well drained Sharpsburg soils are mainly on upland ridgetops and side slopes. Typically, the surface layer is black silty clay loam. The subsurface layer also is black silty clay loam. The subsoil is brown and dark yellowish brown silty clay loam. The substratum is yellowish brown silty clay loam.

The somewhat poorly drained Higginsville soils are mainly on upland side slopes lower on the landscape than the Sharpsburg soils. Typically, the surface layer is very dark grayish brown silty clay loam. The subsoil is brown, dark grayish brown, and grayish brown silty clay loam. The substratum is grayish brown silty clay loam.

The somewhat poorly drained Nevin soils are mainly on terraces lower on the landscape than the Higginsville soils. Typically, the surface layer is black silty clay loam. The subsurface layer is very dark gray silty clay loam. The subsoil is dark grayish brown, mottled silty clay loam. The substratum is coarsely mottled grayish brown and yellowish brown silty clay loam.

Minor soils in this association are the poorly drained Bremer soils on low stream terraces, the poorly drained Colo soils on flood plains and low terraces, and the moderately well drained Shelby soils on side slopes.

This association is used mainly for cultivated crops and small grain. A few scattered areas are used for grasses and legumes for pasture or hay. Some of the narrow upland drainageways are used for woodland.

The nearly level and gently sloping soils are suited to cultivated crops, small grain, and grasses and legumes. The main management concerns are erosion control and the gully formation that results from overgrazing or grazing when the soils are wet. Also, wetness is a problem in some low areas. It may result in an inadequate plant cover. Ponds for livestock water have been constructed in the areas that do not have flowing streams.

This association is suitable for sanitary facilities and building site development. The wetness, the slow permeability, and the shrink-swell potential are the main management concerns.

5. Sharpsburg-Higginsville-Macksburg association

Gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils formed in loess; on uplands

This association consists of soils on broad ridgetops and side slopes. The ridges generally are linear and lie in a north-south direction. They are uniform in elevation. Most areas are drained by small streams that flow east or west into secondary streams. Slopes range from 2 to 9 percent.

This association makes up about 12 percent of the survey area. It is about 53 percent Sharpsburg soils, 23 percent Higginsville soils, 10 percent Macksburg and similar soils, and 14 percent minor soils.

The moderately well drained Sharpsburg soils are mainly on convex ridgetops and side slopes. Typically, the surface layer is black silty clay loam. The subsurface layer also is black silty clay loam. The subsoil is brown and dark yellowish brown silty clay loam. The substratum is yellowish brown silty clay loam.

The somewhat poorly drained Higginsville soils are mainly on upland side slopes. Typically, the surface layer is very dark grayish brown silty clay loam. The subsoil is brown, dark grayish brown, and grayish brown silty clay loam. The substratum is grayish brown silty clay loam.

The somewhat poorly drained Macksburg soils are mainly on ridgetops and upland divides. Typically, the surface layer is black silty clay loam. The subsurface layer is very dark gray silty clay loam. The subsoil is dark grayish brown, grayish brown, and olive gray silty clay loam. The substratum is mottled gray and olive gray silty clay loam.

Minor soils in this association are the poorly drained Colo soils adjacent to drainageways and the moderately well drained Shelby soils on side slopes. Shelby soils have more glacial sand and gravel than the major soils.

This association is used mainly for cultivated crops, small grain, and grasses and legumes. Some of the steeper areas are used mostly for pasture. The narrow upland drainageways generally are used for pasture. In some areas they are used for woodland.

The major soils are suited to cultivated crops and grasses and legumes. The main management concern is erosion control. Overgrazing or grazing when the soil is wet is a concern in managing pastured areas. It results in gully formation, compaction, and a lack of an adequate plant cover. Ponds provide water for livestock in most areas that do not have flowing streams.

This association is suited to sanitary facilities and building site development. The wetness, the shrink-swell potential, and the moderate permeability are the main management concerns.

6. Nodaway-Colo-Zook association

Nearly level, moderately well drained and poorly drained soils formed in silty and clayey alluvium; on flood plains and low terraces

This association consists of soils on flood plains and low terraces along the rivers and major streams. Differences among these soils are mainly the result of variations in the texture of the parent material. Soils in different landscape positions show only slight elevation differences. Generally, the Nodaway soils are in the highest landscape positions nearest the stream channel, and the more clayey Colo and Zook soils are in the

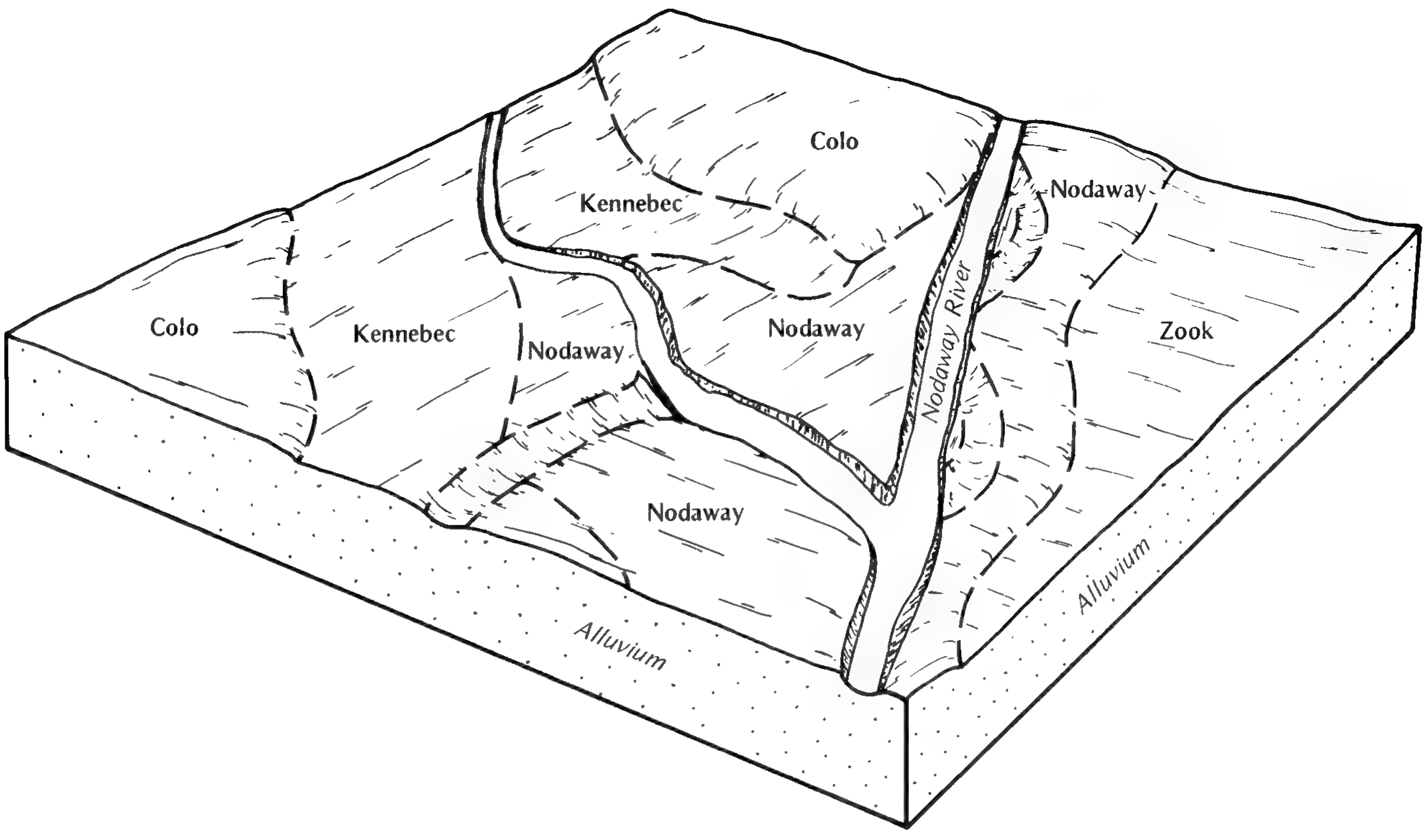

Figure 5.—Typical pattern of soils and parent material in the Nodaway-Colo-Zook association.

lowest positions farther away from the stream channel. Slopes range from 0 to 2 percent.

This association makes up about 15 percent of the survey area. It is about 28 percent Nodaway soils, 28 percent Colo and similar soils, 23 percent Zook soils, and 21 percent minor soils (fig. 5).

The moderately well drained Nodaway soils are mainly on flood plains that have recently received sediment. They are adjacent to the stream channel. Typically, the surface layer is black silt loam. The substratum is stratified very dark gray and dark grayish brown silt loam.

The poorly drained Colo soils are mainly on flood plains or low terraces. Typically, the surface layer is black silty clay loam. The subsurface layer is black and very dark gray silty clay loam. The substratum is dark gray silty clay loam.

The poorly drained Zook soils are mainly on flood plains adjacent to upland foot slopes. Typically, the surface layer is black silty clay loam. The subsurface layer is black and very dark gray silty clay loam and silty clay. The subsoil and substratum are very dark gray and dark gray silty clay.

Minor soils in this association are the moderately well drained Kennebec soils, which are not stratified and are adjacent to stream channels; the somewhat poorly drained Nevin soils on low stream terraces; the moderately well drained Olmitz soils on foot slopes; and the moderately well drained Shelby soils on adjacent upland side slopes.

This association is intensively cultivated. Corn and soybeans are the main crops. A small acreage is woodland. The wooded areas are adjacent to river channels and are subject to flooding.

This association is suited to cultivated crops, small grain, and grasses and legumes. Flooding and wetness are the main concerns of management. Levees help to prevent the damage caused by flooding, and surface drains, such as graded ditches, help to remove excess surface water.

This association generally is unsuitable for building site development and sanitary facilities because of the flooding and the wetness.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Shelby clay loam, 9 to 14 percent slopes, is one of several phases in the Shelby series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils or a soil and a miscellaneous area in such an intricate pattern or so small in extent that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Udorthents-Pits complex is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The Pits in the Udorthents-Pits complex is an example. Some miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of the soils identified on the detailed soil maps of this survey area do not fully agree with those in the surveys of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils that respond to use and management in much the same way was more practical than separating these soils and giving them different names.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

12E2—Gara loam, 14 to 20 percent slopes, eroded. This moderately steep, moderately well drained soil is on dissected upland side slopes, commonly adjacent to stream valleys. Individual areas are irregular in shape and range from 15 to more than 160 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 31 inches thick. The upper part is dark grayish brown and brown, firm clay loam, and the lower part is brown and yellowish brown, mottled, firm clay loam. The upper part of the substratum is yellowish brown, firm clay loam. The lower part to a depth of 60 inches or more is mottled yellowish brown and light brownish gray, firm clay loam. In some areas slopes are less than 14 percent, and in other areas they are more than 20 percent. In areas where nearly all of the original surface layer has been removed by erosion, the surface layer is brown clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Lagonda soils. These soils

are on the upper end of upland drainageways on concave side slopes. They make up about 5 percent of the unit.

Permeability is moderately slow in the Gara soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are pastured or support hardwood trees and shrubs. Because of the moderately steep slope and a severe erosion hazard, this soil generally is unsuitable for cultivated crops. It is well suited to red clover, ladino clover, birdsfoot trefoil, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure rapid growth of a good plant cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are needed.

Some areas support native hardwoods. This soil is suited to trees. The erosion hazard and the equipment limitation are the main management concerns. The design of logging roads and trails should minimize the steepness and length of slopes. Seeding of disturbed areas may be needed after the trees are harvested. In some of the steeper areas, logs should be yarded uphill to logging roads and trails.

This soil is suitable for building site development and sanitary facilities. The slope, the shrink-swell potential, and the moderately slow permeability are limitations. Land shaping or grading is needed to modify the slope on building sites. Otherwise, alternative sites should be considered. Reinforcing footings and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Properly designed sewage lagoons function adequately in the less sloping areas. Also, sewage generally can be piped to the less sloping adjacent areas that are better suited to lagoons.

The shrink-swell potential, frost action, the slope, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts in low areas help to prevent the damage caused by frost action and by shrinking and swelling. Because of the slope, some cutting and filling may be needed. Otherwise, the roads and streets can be designed so that they conform to the natural slope of the land.

The land capability classification is VIe.

13C2—Higginsville silty clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, somewhat poorly drained soil is on upland side slopes. Individual areas are irregular in shape and range from 10 to more than 380 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsoil is firm silty clay loam about 45 inches thick. The upper part is brown and dark grayish brown, and the lower part is grayish brown and mottled. The substratum to a depth of 60 inches or more is grayish brown, mottled silty clay loam. In some areas, the dark surface layer is thicker and the subsoil has more clay.

Included with this soil in mapping are small areas of the moderately well drained Sharpsburg and Shelby soils. Sharpsburg soils are on ridgetops, and Shelby soils are on the lower side slopes. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Higginsville soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility also is high, but organic matter content is moderate because of erosion. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to remain wet from late in fall to early in spring, however, because of a perched seasonal high water table at a depth of 1.5 to 3.0 feet. It also tends to crust or puddle after hard rains, especially in cultivated areas where it contains subsoil material. The shrink-swell potential is moderate.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In most areas slopes are long enough and uniform enough for terracing and for farming on the contour. Excess water can be removed by drainage tile. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to tall fescue, timothy, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion during seedbed preparation is the main management problem. It can be controlled by timely tillage and by a quickly established ground cover.

This soil is suitable for building site development and sanitary facilities, but the wetness, the moderate permeability, the slope, and the moderate shrink-swell potential are limitations. Some land shaping generally is needed to modify the slope. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around

footings helps to prevent the damage caused by excessive wetness. Sewage lagoons function adequately if the sites are leveled and the berms and bottoms are sealed with slowly permeable material, which helps to prevent the contamination of ground water. Also, alternative soil sites that are better suited to waste disposal can be selected.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIIe.

14C2—Lagonda silty clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, somewhat poorly drained soil is on upland side slopes. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. The subsoil is about 52 inches thick. The upper part is dark grayish brown, mottled, friable silty clay loam; the next part is grayish brown, mottled, firm silty clay loam; and the lower part is light brownish gray, mottled, very firm silty clay. The substratum to a depth of 60 inches or more is light brownish gray, mottled, very firm silty clay loam. In some areas the surface layer and subsoil are thicker. In other areas the subsoil has no coarse sand particles. In places more sand particles are in the surface layer and subsoil.

Included with this soil in mapping are small areas of the moderately well drained Sharpsburg and Shelby soils. Sharpsburg soils are on narrow ridgetops, and Shelby soils are on side slopes below the Lagonda soil. Included soils make up about 5 to 10 percent of the unit.

Permeability is slow in the Lagonda soil. Surface runoff is medium in cultivated areas. Available water capacity is moderate. Reaction ranges from mildly alkaline to medium acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic matter content is moderately low. The surface layer is friable, but it can be easily tilled only within a narrow range in moisture content. A seasonal high water table, which is at a depth of 1.5 to 3.0 feet, and the compact silty clay in the subsoil can restrict root development. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In most areas slopes are smooth enough for terracing and for farming on the contour. Excess water can be removed by installing drainage tile in seepy areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion during seedbed preparation is the main management problem. It can be controlled by timely tillage and by a quickly established ground cover.

This soil is suited to building site development and onsite waste disposal systems, but the high shrink-swell potential, the slow permeability, and the seasonal high water table are limitations. Reinforcing basement walls, foundations, and footings and backfilling with sand or gravel help to prevent the structural damage caused by the shrinking and swelling. Installing drainage tile around the footings and underneath basement floors helps to prevent the damage caused by excessive wetness. Sewage is best treated in a lagoon constructed in the less sloping areas.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches, installing culverts, and grading the roads so that they shed water, help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIIe.

15C—Lamoni clay loam, 5 to 9 percent slopes. This moderately sloping, somewhat poorly drained soil is on the upper side slopes and narrow tops of ridges in the uplands. Individual areas are irregular in shape and range from 5 to more than 750 acres in size.

Typically, the surface layer is black clay loam about 7 inches thick. The subsurface layer is very dark gray, friable clay loam about 5 inches thick. The subsoil is clay about 22 inches thick. The upper part is olive brown and brown, mottled, and firm, and the lower part is mottled brown and gray and is very firm. The substratum to a depth of 60 inches or more is multicolored clay loam. The surface layer is silty clay in some areas where it has been mixed with the upper part of the subsoil by plowing.

Included with this soil in mapping are small areas of the moderately well drained Shelby soils and a moderately well drained soil that has a reddish brown subsoil. Shelby soils are on the steeper side slopes. The

other included soil is on secondary ridgetops and is higher on the landscape than the Lamoni soil. Also included are areas where limestone crops out or fragments of limestone are mixed with the surface soil. Included areas make up about 2 to 10 percent of the unit.

Permeability is slow in the Lamoni soil. Surface runoff is medium in cultivated areas. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. A perched seasonal high water table is at a depth of 1 to 3 feet during winter and spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. In some areas, however, seepy spots restrict cultivation during winter and spring. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In some areas slopes are long enough and smooth enough for terracing and for farming on the contour. Excess water can be removed by installing drainage tile in seepy areas. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion during seedbed preparation is the main management problem. It can be controlled by timely tillage and by a quickly established ground cover.

This soil is suited to building site development and some onsite waste disposal systems. The wetness, the slope, the slow permeability, and the shrink-swell potential are limitations. Some land shaping generally is needed to modify the slope on building sites. Reinforcing footings and basement walls and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around footings and foundations helps to prevent the damage caused by excessive wetness. The slope is a limitation on sites for sewage lagoons, but it generally can be overcome by leveling.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIIe.

15D2—Lamoni clay loam, 9 to 14 percent slopes, eroded. This strongly sloping, somewhat poorly drained soil is on upland side slopes. Individual areas are irregular in shape and range from 6 to more than 75 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 6 inches thick. The subsoil is firm clay loam about 34 inches thick. The upper part is mottled dark brown, brown, and dark grayish brown, and the lower part is mottled yellowish brown and light brownish gray. The substratum to a depth of about 60 inches is coarsely mottled grayish brown and brown clay loam. In some areas slopes are less than 9 percent. The surface layer is grayish brown, firm clay loam in areas where it has been mixed with the upper part of the subsoil by plowing.

Included with this soil in mapping are small areas of the moderately well drained Shelby soils. These soils are on the lower side slopes. Also included are some areas where a few flagstones are on the surface or rocks crop out. Included areas make up about 5 to 10 percent of the unit.

Permeability is slow in the Lamoni soil. Surface runoff is rapid in cultivated areas. Available water capacity is moderate. Reaction ranges from neutral to medium acid in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic matter content is moderate. A perched seasonal high water table is at a depth of 1 to 3 feet during winter and spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. In some areas, however, seepy spots seasonally restrict cultivation. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain, but the crops should be grown on a limited basis. Further erosion is a hazard in cultivated areas. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In a few areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately

suited to alfalfa, orchardgrass, and smooth bromegrass. Erosion is the main management problem. Good ground cover is needed at all times if forage production is to be maintained. Nurse crops help to control erosion before newly seeded grasses and legumes are established. Timely tillage, contour tillage, and no-till planting also help to control erosion. Overgrazing should be avoided.

This soil is suited to building site development and sewage lagoons, but the high shrink-swell potential, the wetness, and the slope are limitations. Reinforcing footings and basements and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around footings and foundations helps to prevent the damage caused by the excessive wetness. If possible, the less sloping areas should be selected as sites for dwellings and lagoons. Sites for lagoons generally can be leveled. Sites for dwellings can be modified by land shaping and leveling, or the dwellings can be designed so that they conform to the natural slope of the land.

The shrink-swell potential, frost action, the slope, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling. Because of the slope, some cutting and filling may be needed. Otherwise, the roads and streets can be designed so that they conform to the natural slope of the land.

The land capability classification is IVe.

16B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on the convex tops of upland ridges and on high terraces. Individual areas are irregular in shape and range from 6 to more than 1,900 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 8 inches thick. The subsoil is firm silty clay loam about 36 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown and is mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled silty clay loam. In some areas slopes are less than 2 percent. In some eroded areas the surface layer has been mixed with subsoil material by plowing and is brown silty clay loam. In a few areas, the surface layer is loam and the subsoil has more sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils, small areas of Shelby soils, and small areas of soils that have a red clay loam subsoil. Shelby soils have glacial sand and pebbles and contain less clay than the Sharpsburg soil. Lamoni and Shelby soils are on the lower ridgetops and side slopes. Included soils make up about 8 percent of the unit.

Permeability is moderately slow in the Sharpsburg soils. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in cultivated areas where it contains subsoil material. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. A few are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, water erosion is a hazard. Wind erosion also is a hazard in winter and early in spring unless a cover crop is grown or stubble is left on the surface. Water erosion can be controlled by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. The steeper areas where slopes are long and smooth can be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suitable for building site development and sanitary facilities, but the moderately slow permeability, seepage, the slope, and the shrink-swell potential are limitations. Some land shaping generally is needed to modify the slope. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields. It can be overcome, however, by increasing the length of the laterals. Sewage lagoons function adequately if the sites are leveled and the berms and bottom are sealed with material that helps to prevent seepage.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

16C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on upland divides and side slopes. Individual areas are long and narrow and range from 6 to more than 700 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 6 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 37 inches thick. The upper part is brown, and the lower part is dark yellowish brown and has prominent mottles in shades of gray, brown, and yellow. The substratum to a depth of about 60 inches is yellowish brown and gray, mottled silty clay loam. In some eroded areas the surface layer is brown and dark yellowish brown silty clay loam. In other areas the subsurface layer is gray. In places, the surface layer is loam and the subsoil has more sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Lagonda and Lamoni soils. Lagonda soils are in shallow depressions on side slopes at the end of upland drainageways. Lamoni soils are on side slopes below the Sharpsburg soil. Included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Sharpsburg soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. A few are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, water erosion is a hazard. Wind erosion also is a hazard from late in fall to early in spring. Erosion can be controlled by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In most areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suitable for building site development and sanitary facilities, but the slope, the moderately slow permeability, seepage, and the shrink-swell potential are limitations. Some land shaping may be needed to modify the slope. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields. It can be overcome, however, by increasing the length of the laterals. Sewage lagoons function adequately if the sites are leveled and the berms and bottom are sealed with material that helps to prevent seepage.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

17C—Shelby loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on side slopes or narrow ridgetops in the uplands. Individual areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsoil is about 37 inches thick. It is dark brown, firm clay loam in the upper part and dark brown and dark yellowish brown, mottled, firm clay loam in the next part. The lower part of the subsoil and the substratum to a depth of 60 inches or more are multicolored, firm clay loam. In places the depth to calcareous clay loam is less than 30 inches. In some eroded areas the surface layer is dark brown clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils and small areas of Sharpsburg soils. Sharpsburg soils have more clay and less sand than the Shelby soil. Also, they are higher on the landscape. Lamoni soils are on side slopes that are upslope from the Shelby soil. Included soils make up about 2 to 10 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. A few are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, water erosion and wind erosion are hazards. They can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the

surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In some areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suited to building site development and some kinds of sanitary facilities. The moderately slow permeability, the slope, and the shrink-swell potential are limitations. Reinforcing footings and basement walls and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. If the sites are leveled, sewage lagoons function adequately. Also, they can be constructed in the less sloping adjacent areas that are better suited to lagoons.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

17C2—Shelby clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes and narrow ridgetops in the uplands. Individual areas are irregular in shape and range from 10 to more than 460 acres in size.

Typically, the surface layer is very dark brown clay loam about 7 inches thick. The subsoil is firm clay loam about 40 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 60 inches or more is multicolored clay loam. In some eroded areas the surface layer is dark brown clay loam. In places the depth to calcareous clay loam is less than 30 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils and small areas of Sharpsburg soils. Sharpsburg soils have more clay and less sand in the subsoil than the Shelby soil. Both of the included soils are in the higher positions on the landscape. They make up about 2 to 10 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for pasture and hay. A few are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In some areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil, regularly adding other organic material, and growing a green manure crop improve fertility and increase the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suitable for building site development and sanitary facilities, but the slope, the moderately slow permeability, and the shrink-swell potential are limitations. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields. It generally can be overcome, however, by increasing the length of the lateral field. Sewage lagoons function adequately if the sites can be leveled.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

17D—Shelby loam, 9 to 14 percent slopes. This strongly sloping, moderately well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 20 to more than 700 acres in size.

Typically, the surface layer is very dark brown, friable loam about 11 inches thick. The subsurface layer is dark

brown, friable loam about 7 inches thick. The subsoil is firm clay loam about 19 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam. In places the depth to calcareous clay loam is less than 30 inches. In some eroded areas the surface layer is brown clay loam. Some small areas are moderately sloping or moderately steep.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils. These soils are in the higher landscape positions. They make up about 5 to 10 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is rapid in cultivated areas. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. A few are used for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. A permanent cover of grasses is needed in the steeper areas. Some type of grade stabilization structure generally is needed in the grassed waterways. In nearly all areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to red clover, ladino clover, birdsfoot trefoil, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure rapid growth of a good plant cover. Overgrazing should be avoided. Measures that maintain fertility may be needed.

This soil is suited to building site development and some kinds of sanitary facilities. The slope, the moderately slow permeability, and the shrink-swell potential are limitations. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Building sites should be modified by land shaping, or dwellings should be designed so that they conform to the natural slope of the land. Sewage lagoons function adequately if the sites can be leveled. Also, suitable sites for lagoons generally are available in the less sloping adjacent areas.

The shrink-swell potential, frost action, the slope, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling. Because of the slope, some cutting and filling may be needed. Otherwise, the roads and streets can be designed so that they conform to the natural slope of the land.

The land capability classification is IIIe.

17D2—Shelby clay loam, 9 to 14 percent slopes, eroded. This strongly sloping, moderately well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 15 to about 1,200 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The subsoil is firm clay loam about 37 inches thick. The upper part is dark brown, the next part is dark yellowish brown, and the lower part is light brownish gray. The substratum to a depth of 60 inches or more is mottled light brownish gray, light yellowish brown, and dark yellowish brown clay loam. In places the depth to calcareous clay loam is less than 30 inches. In some severely eroded areas, the surface layer is yellowish brown, firm clay loam. A few areas are moderately steep.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils. These soils are in the higher landscape positions. Also included are some areas of soils that have rock fragments in the subsoil and substratum or have limestone bedrock within a depth of 60 inches. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is rapid in cultivated areas. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable but can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. A permanent plant cover is needed in severely eroded areas. Some type of grade stabilization structure generally is needed in the grassed waterways. In most areas slopes are long enough and smooth enough for

terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to red clover, ladino clover, birdsfoot trefoil, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure rapid growth of a good plant cover. Overgrazing should be avoided. Measures that maintain fertility may be needed.

This soil is suited to building site development and some kinds of sanitary facilities. The slope, the moderately slow permeability, and the shrink-swell potential are limitations. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Building sites should be modified by land shaping, or dwellings should be designed so that they conform to the natural slope of the land. Sewage lagoons function adequately if the sites can be leveled. Also, suitable sites for lagoons generally are available in the less sloping adjacent areas.

The shrink-swell potential, frost action, the slope, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling. Because of the slope, some cutting and filling may be needed. Otherwise, the roads and streets can be designed so that they conform to the natural slope of the land.

The land capability classification is IVe.

17E2—Shelby clay loam, 14 to 20 percent slopes, eroded. This moderately steep, moderately well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 6 to 345 acres in size.

Typically, the surface layer is very dark gray clay loam about 6 inches thick. The subsoil is firm clay loam about 24 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown and mottled. The substratum to a depth of 60 inches or more is mottled light gray, light brownish gray, and yellowish brown clay loam. In some severely eroded areas, the surface layer is yellowish brown, firm clay loam. In places the depth to calcareous clay loam is less than 30 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni soils. These soils are on the higher side slopes. Also included are small areas of rock outcrop and thin ledges of shale on the lower side slopes. Included areas make up about 5 percent of the unit.

Permeability is moderately slow in the Shelby soil and surface runoff is rapid. Available water capacity is high. Organic matter content is moderate, and natural fertility is low. The shrink-swell potential is moderate.

Most areas are used for pasture and hay. Because of the moderately steep slope and a severe erosion hazard, this soil generally is unsuited to cultivated crops. It is well suited to red clover, ladino clover, birdsfoot trefoil, and timothy and moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure rapid growth of a good plant cover. Overgrazing should be avoided. Measures that improve fertility may be needed.

This soil is suitable for building site development and sanitary facilities, but the slope, the shrink-swell potential, and the moderately slow permeability are limitations. Land shaping or grading is needed to modify the slope on building sites. Otherwise, alternative sites should be considered. Reinforcing footings and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Properly designed sewage lagoons function adequately in the less sloping areas. Also, sewage generally can be piped to the less sloping adjacent areas that are better suited to lagoons.

The shrink-swell potential, frost action, the slope, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling. Because of the slope, some cutting and filling may be needed. Otherwise, the roads and streets can be designed so that they conform to the natural slope of the land.

The land capability classification is VIe.

18C2—Clarinda silty clay loam, 5 to 9 percent slopes, eroded. This moderately sloping, poorly drained soil is on concave slopes at the head of drainageways and on the sides of ridges in the uplands. Individual areas are irregular in shape and range from 10 to 110 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. The subsoil is about 47 inches thick. The upper part is dark gray, mottled, firm silty clay, and the lower part is gray and olive gray, mottled, firm and very firm clay. The substratum to a depth of 60 inches or more is olive gray clay. In some eroded areas the surface layer is gray silty clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Lagonda soils and the moderately well drained Shelby soils. Lagonda soils are on the higher side slopes. Shelby soils are on the lower side slopes. Included soils make up about 5 to 10 percent of the unit.

Permeability is very slow in the Clarinda soil. Surface runoff is medium in cultivated areas. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderate. A perched seasonal high water table is at a depth of 1 to 3 feet from November through April. The surface layer is friable, but it can be easily tilled only within a narrow range in moisture content. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If row crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface compaction and crusting, and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and switchgrass and moderately suited to most other warm-season grasses and tall fescue. It is not suited to deep-rooted plants. It is best suited to the grasses and legumes that can withstand the wetness. Erosion is the main management problem. Tillage should be on the contour. Rotation grazing helps to prevent overgrazing.

This soil is poorly suited to building site development. Dwellings generally can be built on the adjacent soils that are better building sites. If dwellings are built on this soil, measures that overcome the shrink-swell potential and the wetness are needed. Reinforcing basements and footings and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Drainage tile helps to remove excess water. The soil is suited to sewage lagoons if the sites are leveled.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IVe.

19B—Macksburg silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on upland ridgetops and on the sides of high stream terraces. Individual areas are irregular in shape and range from 15 to about 500 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 5 inches thick. The subsoil is mottled, firm silty clay loam about 47 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown and olive gray. The substratum to a depth of 65 inches or more is gray and olive gray, mottled silty clay loam. In places the surface layer is silt loam. In some eroded areas it is dark grayish brown silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained Sharpsburg and Shelby soils. Sharpsburg soils are in the higher landscape positions. Shelby soils are on the lower side slopes. Included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Macksburg soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content are high. A seasonal high water table commonly is at a depth of 2 to 4 feet early in the growing season. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay (fig. 6). This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In nearly all areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion during seedbed preparation is the main management problem. It can be controlled by timely tillage and by a quickly established ground cover.

This soil is suited to building site development and sewage lagoons, but the high shrink-swell potential and the wetness are limitations. Reinforcing basement walls and floors and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The wetness can be reduced by installing tile drains around footings and foundations. Sealing the bottom of sewage lagoons with slowly permeable

Figure 6.—Soybeans and wheat on Macksburg silty clay loam, 2 to 5 percent slopes.

material helps to prevent the contamination of ground water.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIe.

20C2—Ladoga silt loam, 5 to 9 percent slopes, eroded. This moderately sloping, moderately well drained soil is on ridgetops and high terraces adjacent to the major and some of the minor stream valleys. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is dark brown silt loam about 6 inches thick. The subsoil to a depth of 60 inches or more is firm silty clay loam. The upper part is brown, the next part is brown and mottled, and the lower part is dark yellowish brown and grayish brown and is mottled. In some eroded areas the surface layer is very dark brown or brown silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Pershing soils. These soils are lower on the landscape than the Ladoga soil. They make up about 5 to 10 percent of the unit.

Permeability is moderately slow in the Ladoga soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust after hard rains, however, especially in cultivated areas where it

contains subsoil material. The shrink-swell potential is moderate.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In a few areas slopes are long enough and smooth enough for terracing and for farming on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suited to trees. Plant competition is a management concern. It generally can be overcome by thorough site preparation, which may include spraying or cutting. No other limitations or hazards affect planting or harvesting.

This soil is suited to building site development and some onsite waste disposal systems. The moderately slow permeability, the slope, and the moderate shrink-swell potential are limitations. Some land shaping generally is needed to modify the slope. Also, the buildings can be designed so that they conform to the natural slope of the land. Reinforcing foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Sewage lagoons can function properly if they are constructed in the less sloping areas or the sites are leveled. Sealing the bottom of the lagoon with slowly permeable material helps to prevent seepage.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

25C—Pershing silt loam, 5 to 9 percent slopes. This moderately sloping, somewhat poorly drained soil is on convex side slopes bordering interstream divides along the major streams. Individual areas are long and narrow and range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 7 inches thick. The subsoil to a depth of 60 inches or more is silty clay loam. The upper part is dark grayish brown and brown, mottled, and friable and firm; the next part is multicolored; and the lower part is dark grayish brown, mottled, and firm. In some eroded areas the surface layer is dark grayish brown silty clay loam. In places slopes are less than 5 percent.

Included with this soil in mapping are small areas of the moderately well drained Ladoga soils on side slopes. These soils make up about 5 to 10 percent of the unit.

Permeability is slow in the Pershing soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. A seasonal high water table is at a depth of 2 to 4 feet from November through April. The surface layer is very friable but can be easily tilled only within a somewhat limited range in moisture content. It tends to remain wet after periods of heavy rains, especially in cultivated areas where it contains subsoil material. The shrink-swell potential is high.

This soil is moderately well suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, terraces and grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In most areas slopes are long enough and smooth enough for terracing. Excess water can be removed by drainage tile. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

Most areas are used for pasture and hay. This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion during seedbed preparation is the main management problem. It can be controlled by tillage and by a quickly established ground cover.

This soil is suited to trees. Seedling mortality and the windthrow hazard are the main management concerns. Planting stock that is larger than is typical improves the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight.

This soil is suitable for building site development and some onsite waste disposal systems. The slow

permeability, the wetness, the slope, and the high shrink-swell potential are limitations. Reinforcing basement walls, footings, and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The slope should be modified by land shaping, or dwellings should be designed so that they conform to the natural slope of the land. Installing tile drains around footings and foundations helps to prevent the damage caused by excessive wetness. Sewage lagoons function adequately, but the slope is a limitation during construction. The sites generally can be leveled, or the sewage can be piped to less sloping areas that are better suited to lagoons.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is IIIe.

40E—Vanmeter silt loam, 9 to 45 percent slopes. This moderately deep, strongly sloping to very steep, moderately well drained soil is on upland side slopes. Individual areas are irregular in shape and range from 6 to about 70 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is friable and firm, olive brown silty clay loam about 16 inches thick. The substratum is light olive brown silty clay loam about 8 inches thick. It is underlain by soft, weathered shale bedrock. In places the depth to weathered bedrock is less than 20 inches. In some areas, the soil has a few fragments of limestone or thin ledges of limestone are evident.

Included with this soil in mapping are small areas of the deep, moderately well drained Gara, Ladoga, and Shelby soils and small areas of rock outcrop. Included areas are on the higher parts of the landscape. They make up about 5 percent of the unit.

Permeability is very slow in the Vanmeter soil, and surface runoff is medium or rapid. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The surface layer is friable. Root development is restricted by the shale below a depth of about 28 inches. The shrink-swell potential is high.

Most areas are used for wildlife habitat. Some are idle. This soil is unsuited to cultivated crops because of the slope and the rapid runoff. The silt loam surface layer is subject to severe erosion if cultivated.

Growing grasses and legumes for pasture is very effective in controlling erosion. This soil is moderately well suited to birdsfoot trefoil, tall fescue, indiangrass, and bluestems. It generally is not suited to hay because of the slope. Timely reseeding helps to control erosion in areas where trees and brush have been removed. A permanent cover crop should be established and maintained at all times. Shallow-rooted plants that can withstand droughtiness should be selected for planting in the pastured areas. Brush control is needed. Overgrazing should be avoided.

Trees and brush grow in some areas. This soil is suited to trees. Because of low production rates, however, intensive timber management generally is not economical.

This soil generally is unsuited to building site development and sanitary facilities because of the slope, the very slow permeability, the depth to shale, and the high shrink-swell potential.

The land capability classification is VIIe.

56B—Olmitz loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on slightly concave or plane foot slopes in the uplands. Individual areas are long and narrow or irregular in shape and range from 20 to about 300 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is about 19 inches thick. It is black. It is loam in the upper part and clay loam in the lower part. The subsoil to a depth of 60 inches or more is very dark grayish brown, friable and firm clay loam. In some areas the surface layer is clay loam.

Included with this soil in mapping are small areas of the poorly drained Colo and Zook soils and the moderately steep Gara soils. Colo and Zook soils are on flood plains. Gara soils are on the higher upland side slopes. Their dark surface layer is thinner than that of the Olmitz soil. Also included, in the lower areas adjacent to flood plains or stream channels, are soils that are subject to rare flooding. Included soils make up about 2 to 5 percent of the unit.

Permeability is moderate in the Olmitz soil. Surface runoff generally is medium in cultivated areas, but it varies. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants and hay. Some type of grade stabilization structure generally is needed in the grassed waterways. In many areas slopes are long enough and smooth enough for terracing and for farming on the

contour. Returning crop residue to the soil or regularly adding other organic material helps to maintain fertility.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suited to building site development and sanitary facilities, but the shrink-swell potential, seepage, and the moderate permeability are limitations. Reinforcing footings and basement walls and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The restricted permeability is a limitation in septic tank absorption fields. It can be overcome, however, by increasing the length of the laterals. Sewage lagoons function properly if the bottom and berms are sealed with special material that helps to prevent seepage.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

57—Wiota silty clay loam. This nearly level, moderately well drained soil is on low stream terraces a few feet above the adjacent flood plains. Individual areas are irregular in shape and range from 7 to about 250 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 26 inches thick. The subsoil to a depth of 60 inches or more is silty clay loam. The upper part is dark brown and friable, and the lower part is brown and is friable and firm. In some areas the subsoil is grayer.

Included with this soil in mapping are small areas of the poorly drained Bremer and Colo soils. Bremer soils are in the flatter areas. Colo soils are adjacent to drainageways. Included soils make up about 5 percent of the unit.

Permeability is moderate in the Wiota soil. Surface runoff is medium in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a moderate hazard on the short slopes. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface. Winter cover crops help to prevent the excessive soil loss caused by high winds late in winter and early in spring. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to all of the legumes, warm-season grasses, and cool-season grasses commonly grown in the county. No serious problems affect management of the soil for pasture and hay. Erosion is a hazard before newly seeded grasses and legumes are established. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suited to building site development and sanitary facilities, but the shrink-swell potential, seepage, and the moderate permeability are limitations. Reinforcing footings and basement walls and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. The restricted permeability is a limitation in septic tank absorption fields. It can be overcome, however, by increasing the length of the laterals. Sewage lagoons function properly if the bottom and berms are sealed with special material that helps to prevent seepage.

The shrink-swell potential, frost action, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is I.

58—Nevin silty clay loam. This nearly level, somewhat poorly drained soil is on low stream terraces. Individual areas are irregular in shape and range from 10 to more than 940 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is very dark gray, friable and firm silty clay loam about I5 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay loam about 27 inches thick. The substratum to a depth of about 60 inches is coarsely mottled grayish brown and yellowish brown silty clay loam. In some areas the subsoil contains more clay.

Included with this soil in mapping are small areas of the poorly drained Bremer and moderately well drained Wiota soils. Bremer soils are in positions on the stream terraces similar to those of the Nevin soil or are in slightly lower areas. Wiota soils are in the slightly higher landscape positions. Included soils make up about 5 percent of the unit.

Permeability is moderate in the Nevin soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content also are high. A seasonal high water table is at a depth of 2 to 4 feet from November through July. It can restrict root development and crop growth. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. In cultivated areas where it is thin or contains subsoil material, however, it tends to crust or puddle after hard rains. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. A conservation tillage system that leaves protective amounts of crop residue on the surface helps to control wind erosion in winter and spring, helps to maintain fertility, and increases the rate of water infiltration.

This soil is well suited to ladino clover and moderately well suited to timothy, tall fescue, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, orchardgrass, and smooth bromegrass. The species that can be grazed during wet periods grow best.

This soil is suited to building site development and some onsite waste disposal systems. The wetness, the shrink-swell potential, seepage, and the moderate permeability are limitations. Reinforcing footings and foundations and backfilling with sand or gravel help to prevent the structural damage caused by shrinking and swelling. Installing tile drains around the footings helps to prevent the damage caused by excessive wetness. Sealing the sides and bottom of sewage lagoons with slowly permeable material helps to prevent seepage.

The shrink-swell potential, frost action, the wetness, and low strength are limitations if this soil is used as a site for local roads and streets. Providing crushed rock or other suitable base material helps to prevent the damage caused by low strength. Establishing adequate side ditches and installing culverts help to prevent the damage caused by frost action, wetness, and shrinking and swelling.

The land capability classification is I.

59—Bremer silty clay loam. This nearly level, poorly drained soil is on low stream terraces. It is occasionally flooded. Individual areas are irregular in shape and range from 10 to more than 430 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer also is black silty clay loam about 10 inches thick. The subsoil is mottled silty clay loam about 30 inches thick. The upper part is very dark gray and grayish brown and is very firm, and the lower part is gray and firm. The substratum to a depth of 60 inches or more is gray, mottled silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained Kennebec and Nodaway soils. These soils are on flood plains adjacent to stream channels. They make up about 5 percent of the unit.

Permeability is moderately slow in the Bremer soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content also are high. A seasonal high water table is at a depth of 1 to 2 feet from November through July. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content, but it tends to remain wet for long periods during the wetter parts of the year. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, the flooding can cause crop damage. It can be controlled, however, by levees. Drainage tile and land grading improve internal and surface drainage. Land grading also fills in small depressions. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil, ladino clover, and bluegrass. It is best suited to the shallow-rooted grasses and legumes that can withstand wetness. It is poorly suited to hay. The wetness and the flooding are the main management problems. The flooding should be considered when the grazing system is designed. Maintaining stands of desirable species is difficult in depressional areas. The more deeply rooted species can grow better if a surface drainage system is installed.

This soil is suited to trees. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Equipment should be used only during periods when the ground is dry or frozen. Ridging the soil and then planting on the ridges increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where the windthrow hazard is slight. Plant competition can be controlled by careful site preparation, which may include spraying or cutting.

This soil generally is unsuitable for building site development and sanitary facilities because of the occasional flooding.

The land capability classification is IIw.

90—Udorthents-Pits complex. This map unit occurs as areas of very poorly drained to excessively drained soils on spoil banks closely intermingled with excavations from which the original soil material and the underlying layers of limestone and shale have been removed. Slopes are nearly level on the floor of the Pits and range from nearly level to very steep in the areas of Udorthents. Individual areas are nearly square or rectangular and range from 5 to 65 acres in size.

The Udorthents consist of loamy and clayey material and varying amounts of limestone and shale fragments. The size of the fragments varies.

The Pits are open excavations that have nearly level bottoms and nearly vertical walls.

Included with this unit in mapping are small, undisturbed areas of Gara, Sharpsburg, Shelby, and Vanmeter soils. These soils are on ridgetops and side slopes above the excavations. Also included in some of the excavations are small areas of water. Included areas make up about 10 percent of the unit.

Permeability, available water capacity, reaction, natural fertility, and organic matter content vary greatly in this unit. Surface runoff ranges from ponded along the floors of the Pits to very rapid on the nearly vertical walls.

Most areas of this unit are no longer quarried, but limestone is being removed from a few of the excavations. The unit is best suited to wildlife habitat or recreational purposes. The Udorthents support various native plants that provide suitable habitat for wildlife. Several species of game fish inhabit some of the larger areas of ponded water.

This unit is not suited to building site development and sanitary facilities because of the slope and the depth to rock.

No land capability classification is assigned.

99A—Colo silty clay loam, channeled, 0 to 3 percent slopes. This nearly level, poorly drained soil is in the lower areas in narrow upland drainageways near stream channels. It is frequently flooded. Individual areas are narrow and elongated and range from 10 to more than 100 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is friable silty clay loam about 25 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of 60 inches or more is very dark gray silty clay loam. In some areas the surface layer is silt loam or loam overwash. In other areas bedrock or flagstones are at a depth of 30 to 40 inches.

Included with this soil in mapping are small areas of the moderately well drained Kennebec and Nodaway soils. These soils are somewhat higher on the landscape than the Colo soil. They make up about 10 percent of the unit.

Permeability is moderate in the Colo soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content also are high. A seasonal high water table is at a depth of 1 to 3 feet from November through July. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is high.

Most areas are used for pasture or hay. This soil generally is not suitable for cultivated crops because of the flooding and the seasonal high water table. Also, most areas are long and narrow and are dissected by watercourses and their smaller tributaries.

This soil is moderately suited to reed canarygrass and alsike clover. It is best suited to the shallow-rooted grasses and legumes that can withstand wetness. It is poorly suited to hay. The wetness and the flooding are the main management problems. The flooding should be considered when the grazing system is designed. Preparing a seedbed is difficult only during wet periods. The more deeply rooted species can grow better if a surface drainage system is installed.

This soil generally is unsuited to building site development and sanitary facilities because of the frequent flooding and the seasonal high water table.

The land capability classification is Vw.

100—Colo silty clay loam. This nearly level, poorly drained soil is on large flood plains adjacent to the uplands and in areas of small drainageways and fans on low stream terraces. It is occasionally flooded. Some areas are protected by levees but can be flooded if a levee breaks or if the soil receives runoff from adjacent areas. Individual areas are irregular in shape and range from 7 to more than 790 acres in size.

Typically, the surface layer is black silty clay loam about 6 inches thick. The subsurface layer is friable silty clay loam about 34 inches thick. The upper part is black, and the lower part is very dark gray. The next 12 inches is very dark gray, mottled, friable silty clay loam. The substratum to a depth of 60 inches or more is dark gray, mottled silty clay loam. In places the surface layer is loam or silt loam overwash. In some areas adjacent to foot slopes, the subsurface layer contains more clay.

Included with this soil in mapping are small areas of the moderately well drained Kennebec and Nodaway soils adjacent to stream channels. Kennebec soils contain less clay than the Colo soil. Nodaway soils are stratified with recent sediments. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Colo soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content are high. A seasonal high water table is at a depth of 1 to 3 feet. The soil tends to remain wet for long periods in winter and spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is high.

Most areas are used for cultivated crops or for pasture and hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, the flooding can cause crop damage. It can be controlled, however, by levees. Ponded or other excess surface water can be removed by graded drainage ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is moderately suited to reed canarygrass and alsike clover. It is best suited to the shallow-rooted

grasses and legumes that can withstand wetness. It is poorly suited to hay. The wetness and the flooding are the main management problems. The flooding should be considered when the grazing system is designed. Preparing a seedbed is difficult only during wet periods. The deeper rooted species can grow better if a surface drainage system is installed.

This soil generally is unsuited to building site development and sanitary facilities because of the occasional flooding and the seasonal high water table.

The land capability classification is IIw.

101—Nodaway silt loam. This nearly level, moderately well drained soil is on flood plains that have recently received sediments. It is occasionally flooded. Individual areas are long and narrow and range from 20 to more than 1,800 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The substratum to a depth of 60 inches or more is silt loam. The upper part is stratified very dark gray and dark grayish brown, and the lower part is very dark gray and firm.

Included with this soil in mapping are small areas of the poorly drained Colo and Zook soils along flood plains and on low terraces and some small areas of Kennebec soils along stream channels. The dark surface layer of Kennebec soils is thicker than that of the Nodaway soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Nodaway soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. A seasonal high water table is at a depth of 3 to 5 feet during winter and spring. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is well suited to corn, soybeans, and small grain. It is subject to scouring and deposition, however, during periods of flooding, usually in winter. It also is subject to wind erosion unless a cover crop is grown or stubble is left on the surface. A conservation tillage system that leaves protective amounts of crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material helps to maintain fertility.

If the flooding is of short duration, this soil is well suited to alfalfa, red clover, and switchgrass and moderately well suited to orchardgrass, smooth bromegrass, and most other warm-season grasses. The species that can withstand the wetness grow best. The flooding is the main management problem. It should be considered when the grazing system is designed.

This soil is suited to trees. Plant competition is a management concern. It generally can be overcome by thorough site preparation, which may include spraying or cutting. No other limitations or hazards affect planting or harvesting.

This soil generally is unsuitable for building site development and sanitary facilities because of the occasional flooding.

The land capability classification is IIw.

104—Zook silty clay loam. This nearly level, poorly drained soil is on flood plains along the larger streams. It is occasionally flooded. Individual areas are elongated and range from 10 to more than 930 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is about 39 inches thick. It is black, friable silty clay loam in the upper part and black and very dark gray, firm silty clay loam and silty clay in the lower part. The subsoil is dark gray, mottled, firm silty clay about 11 inches thick. The substratum to a depth of 60 inches or more is dark gray silty clay. In several small areas the surface layer is silty clay. In many areas the content of clay is lower below the surface layer.

Included with this soil in mapping are small areas of the moderately well drained Nodaway soils adjacent to the stream channels. These soils are silt loam throughout. They make up about 10 to 15 percent of the unit.

Permeability is slow in the Zook soil. Surface runoff is slow in cultivated areas (fig. 7). Available water capacity is high. Natural fertility and organic matter content also are high. A seasonal high water table is at a depth of 1 to 3 feet during winter and spring. The surface soil is sticky when wet and can be easily tilled only under optimum moisture conditions. If cultivated when wet, the soil is cloddy and cannot be easily managed. The shrink-swell potential is high.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. Excess water generally can be removed by surface ditches. Land grading helps to fill in potholes and results in a plane surface that is suitable for drainage. A cover of crop residue and deep tillage improve tilth and internal drainage.

This soil is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil, ladino clover, and bluegrass. It is best suited to the shallow-rooted grasses and legumes that can withstand wetness. It is poorly suited to hay. The wetness and the flooding are the main management problems. The flooding should be considered when the grazing system is designed. It can be controlled by dikes and levees. Maintaining stands of desirable species is difficult in depressional areas. The deeper rooted species can grow better if a surface drainage system is installed. Land grading and ditches help to remove excess surface water.

This soil generally is unsuitable for building site development and sanitary facilities because of the occasional flooding.

The land capability classification is IIw.

Figure 7.—Water on Zook silty clay loam.

105—Kennebec silt loam. This nearly level, moderately well drained soil is on flood plains adjacent to river channels. It is frequently flooded. Individual areas are irregular in shape and range from 20 to more than 500 acres in size.

Typically, the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is very dark gray and very dark grayish brown, friable silt loam about 15 inches thick. The next 10 inches is very dark grayish brown, friable silt loam. The substratum to a depth of 60 inches is dark grayish brown silt loam and silty clay loam. In some areas the surface layer is loam overwash about 9 inches thick. In other areas the substratum is stratified.

Included with this soil in mapping are small areas of the poorly drained Colo soils. These soils are somewhat lower on the landscape than the Kennebec soil. They make up about 2 to 10 percent of the unit.

Permeability is moderate in the Kennebec soil. Surface runoff is slow in cultivated areas. Available water capacity is high. Natural fertility and organic matter content also are high. A seasonal high water table is at a depth of 3 to 5 feet from November through July. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, scouring and flooding are hazards along small upland streams and tributaries. The areas along the major streams are subject to longer periods of flooding. The soil also is subject to wind erosion unless a cover crop is planted. Floodwater can be diverted from cultivated areas by levees. Returning crop residue to the soil or regularly adding other organic material improves tilth and helps to maintain fertility.

Some areas can be used for pasture or hay if they are protected by levees. If flooding is of short duration or does not occur during the growing season, this soil is well suited to legumes and most cool-season grasses and is well suited to switchgrass and moderately well suited to most other warm-season grasses. The species that can withstand the wetness grow best. The flooding is the main problem. It should be considered when the grazing system is designed.

This soil is suited to trees. Plant competition is a management concern. It generally can be overcome by thorough site preparation, which may include spraying or burning. No other limitations or hazards affect planting or harvesting.

This soil generally is unsuitable for building site development and sanitary facilities because of the frequent flooding.

The land capability classification is IIw.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland. The loss of prime farmland to urban and other uses puts pressure on marginal lands, which generally are less productive.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cropland, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber or is available for those uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. Slopes range mainly from 0 to 5 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 202,160 acres in Nodaway County, or about 36 percent of the total acreage, meets the requirements for prime farmland. More than 104,000 acres of the prime farmland occurs as areas of Sharpsburg silty clay loam, 2 to 5 percent slopes. Most of the rest occurs as alluvial soils on stream flood plains and terraces. Most of the prime farmland is used for cultivated crops, pasture, or hay.

The map units that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

If a soil meets the requirements for prime farmland only in areas where it is drained or is not frequently flooded during the growing season, a note is added in parentheses after the soil name in table 5. Onsite investigation is needed to determine whether or not a specific area of the soil is adequately drained or is frequently flooded during the growing season. The naturally wet soils in Nodaway County generally have been adequately drained through the application of drainage measures or because of the incidental drainage that results from farming, roadbuilding, or other kinds of land development.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 454,000 acres in the county, or 81 percent of the total acreage, was used for crops and pasture in 1979 (*15*). Of this total, about 39,000 acres was used for permanent pasture; 310,000 acres for cultivated crops, mainly corn, soybeans, grain sorghum, and wheat; and 55,000 acres for rotation hay and pasture. The remaining 50,000 acres was used mostly for conservation purposes or was idle cropland. Because of the fluctuations in the livestock market in the 1970's, the acreage used for row crops has increased and the acreage of permanent pasture has correspondingly decreased.

The potential of the soils in Nodaway County for sustained production of food is good. About 202,160 acres is prime farmland. Only about 117,000 acres, or 21 percent of the cropland and pasture, however, is adequately treated by conservation measures. The cropland that is not adequately treated is mostly on uplands where cultivation causes erosion in excess of what is considered tolerable if production is to be sustained over a long period. Some of the marginal cropland used for row crops should be converted to pasture and hayland. Erosion on most of the cropland can be held to a tolerable amount by a system of conservation practices designed for specific sites. This survey can greatly facilitate the application of such technology.

The paragraphs that follow describe the main management concerns in the areas used for crops and pasture.

Soil erosion is the major problem on nearly all of the cropland and overgrazed pasture in Nodaway County. If the slope is more than 2 percent, the soils are susceptible to erosion.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Clarinda, Lagonda, and Lamoni soils. Second, erosion on farmland can result in pollution of streams, lakes, and ponds by sediment. Controlling

erosion improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing the pollution of streams. Such control also prolongs the useful life of ponds and lakes because it keeps them from being filled with sediment.

In many fields seedbed preparation and tillage are difficult on clayey spots where the original friable surface soil has eroded away. Such spots occur in eroded areas of Clarinda, Lagonda, and Lamoni soils.

Erosion-control practices provide a protective plant cover, reduce the runoff rate, and increase the infiltration rate. A cropping system that keeps a vegetative cover or crop residue on the soil can hold erosion losses to an amount that will not reduce the productive capacity of the soils. Growing grasses and legumes for pasture and hay is very effective in controlling erosion. If used in crop rotations, legumes, such as clover and alfalfa, also improve tilth and provide nitrogen for the following crop.

Terraces reduce the length of slopes and the hazards of runoff and erosion. Conventional terraces combined with grassed waterways or tile outlets are most practical on uneroded upland soils that have long, smooth slopes of less than 8 percent. Special construction and management techniques are needed if terrace systems are to be effective in most areas of the strongly sloping Gara, Lamoni, and Shelby soils. Grassed back-slope terraces reduce the slope. Because conventional terraces actually increase the slope, additional erosion-control measures are crucial. On these soils, a cropping system that provides a substantial vegetative cover or a conservation tillage system that leaves a large amount of crop residue on the surface is effective in controlling erosion. Soil loss on the moderately steep Shelby and Gara soils is severe if cultivated crops are grown. Minimizing tillage on sloping soils and leaving large amounts of crop residue on the surface increase the rate of infiltration and reduce runoff and erosion. These practices are suited to many of the soils in the county but are less successful on eroded soils that have a clayey surface layer. Special management techniques are needed if terracing exposes the clayey subsoil in Clarinda, Lagonda, and Lamoni soils.

If soils are unsuited to terraces, other erosion-control measures can be used. Contour stripcropping is an example. Strips of close-growing crops are alternated with strips of clean-tilled crops. Buffer stripcropping consists of contoured strips of permanent vegetation between or below cultivated strips. Such grass or grass-legume strips generally are used for hay. Row crops planted on the contour are grown in the areas between the strips. No-till farming is becoming more common and is effective in controlling erosion in the more sloping areas. It is effective on many soils in the county, but special management techniques are needed in severely eroded areas.

Soil drainage and flood control are management concerns on about 15 percent of the acreage used for crops and pasture. Bremer and Zook soils are naturally so wet that crops are damaged during some part of the year. Land grading or surface drainage may be needed on these soils. Flooding can be a problem on Colo, Kennebec, and Nodaway soils, commonly from November through May.

Soil fertility is naturally lower in most of the eroded soils than in the uneroded soils. On all soils, however, additional plant nutrients are needed. Most soils are naturally acid in the upper part of the root zone. On these soils, applications of ground limestone are needed to raise the pH and calcium level sufficiently for good growth of legumes. On all soils, applications of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime needed.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Most of the uneroded upland soils used for crops have a silt loam or silty clay loam surface layer that is dark and has a moderate to high content of organic matter. Generally, the structure of the silt loam soils is weakened by tillage and compaction. Intense rainfall causes the formation of crust on the surface of these soils. The crust is hard when dry and reduces the rate of water infiltration and increases the runoff rate. Regular additions of crop residue, manure, and other organic material improve the soil structure and tilth.

All of the eroded upland soils have a higher clay content in the surface layer than uneroded soils. Also, tilth is poorer, the infiltration rate is slower, and the runoff rate is more rapid. On these soils, conservation measures are needed to control further erosion.

Fall plowing is common in the county but generally is not practical on most of the upland soils. Most of the cropland consists of sloping soils that are subject to damaging erosion if plowed in the fall.

Tilth is a problem in the clayey Bremer and Zook soils because these soils commonly stay wet until late in spring. If the soils are plowed when wet, they tend to be cloddy when dry. As a result of the cloddiness, preparing a seedbed is difficult. Plowing these nearly level soils in the fall generally results in better tilth and does not result in damaging erosion.

Irrigation systems are currently being used in some areas in Nodaway County. Some are supplied by wells, rivers, and creeks. Most of these are on bottom land. Only center pivot, gated pipe, and rain-gun systems are used. Such systems provide supplemental water during critical periods of crop growth. Irrigation also makes double cropping an alternative. Soybeans can be planted directly into wheat stubble. The irrigation system supplies enough water to ensure germination and crop growth.

The large amount of crop residue on the surface helps to control erosion.

When the costs and benefits of an irrigation system are considered, soil and water conservation should also be considered. Immediately after irrigation, the saturated topsoil is extremely vulnerable to erosion if intense rainfall occurs. Such accelerated erosion can drastically reduce natural fertility and cause rapid sedimentation in any body of water downstream. Irrigation systems supplied by reservoirs in or near watershed areas can cause sedimentation, which can reduce the irrigation capacity. As a result, protection of the topsoil from erosion is crucial.

Another management need in irrigated areas is the careful maintenance of terraces. If ruts are allowed to develop where the wheels of the system pass over the saturated terrace berm, the effectiveness of the terraces is reduced.

Field crops suited to the soils and climate in the county are corn, soybeans, and grain sorghum. In 1981, corn and soybeans were grown on about 236,000 acres and grain sorghum on 5,000 acres.

Wheat is the most common close-growing crop. It was grown on about 17,000 acres in 1981. Oats and rye can be grown, and grass seed could be produced from smooth bromegrass, tall fescue, and orchardgrass.

Pasture plants and hay crops suited to the soils and climate in the county include several kinds of legumes, cool-season grasses, and warm-season native grasses. Alfalfa and red clover are the common legumes grown for hay. They are also grown as mixtures with smooth bromegrass, orchardgrass, or timothy for hay and pasture. Most of the soils in the county are also suited to ladino clover, birdsfoot trefoil, and tall fescue.

Warm-season native grasses adapted to the county are big bluestem, indiangrass, and switchgrass. These grasses grow well during the hot summer months. Different management techniques are needed for establishing and grazing these grasses than for establishing and grazing cool-season grasses.

Alfalfa is best suited to deep, moderately well drained soils, such as Gara, Kennebec, Ladoga, Nodaway, Olmitz, Sharpsburg, Shelby, and Wiota soils. The other legumes and most cool-season grasses grow well on most of the upland soils in the county. On Bremer, Clarinda, Colo, Higginsville, Lagonda, Lamoni, Macksburg, Nevin, Pershing, and Zook soils, the species that can tolerate wetness should be selected for planting.

The major management concerns on most of the pasture are overgrazing and gully erosion. Timely seeding, minimizing tillage, and establishing ground cover as soon as possible help to prevent excessive erosion. Grazing should be controlled so that the plants survive and grow well. Grazing when the soils are wet causes surface compaction and reduces the rate of water infiltration. Keeping grasses at a desirable height reduces the runoff rate and helps to prevent gully erosion. Timely mowing reduces competition from undesirable plants and helps to achieve a uniform distribution of grazing.

Specialty crops, such as popcorn, sunflowers, and Christmas trees, are grown on small acreages in the county. Special equipment, management, and propagation techniques are needed if these crops are grown.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in table 6.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth,

or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*13*). Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production. There are no class VIII soils in Nodaway County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit, except for the Udorthents-Pits complex, is given in the section "Detailed Soil Map Units" and in table 6.

Woodland Management and Productivity

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each suitable soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *a* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and

strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and Environmental Plantings

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

The soils in all of the soil associations described under the heading "General Soil Map Units," except for the Nodaway-Colo-Zook association, formed under prairie vegetation. In some areas, however, the soils formed under forest vegetation and are still timbered. These areas generally are on the steeper slopes along the drainageways. Most upland soils are fairly barren of trees that provide protection from the wind.

Windbreaks moderate the effects of temperature around farmsteads and feedlots and reduce energy needs for home heating. Field windbreaks also moderate the effects of hot, dry winds that contribute to crop stress in the summer.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service, the Missouri Department of Conservation, or the Cooperative Extension Service or from a commercial nursery.

Recreation

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

The facility inventory portion of the 1980 Statewide Comprehensive Outdoor Recreation Plan (SCORP) indicates a total of 705 acres of recreational areas in Nodaway County (*11*). Ownership of these areas is 48 percent state, 14 percent municipal, 26 percent school, and 12 percent other. The facilities include lakes, river sport areas, swimming areas, hunting and fishing areas, a golf course, hiking trails, game courts, a fairground, ballfields, picnic areas, play areas, a horse arena, and a wildlife viewing area. The demand for recreational facilities is likely to increase because of a projected increase in the total county population by 1990 (*4*).

There are no major public recreation areas in the county. Only two, the Nodaway County Community Lake and the Northwest Missouri State College area, are larger than 100 acres in size. The lake, which is controlled by the state, offers upland game hunting, fishing, picnicking, hiking, and primitive camping. The college offers access to the grounds, game courts, and an indoor swimming pool.

According to the 1974 NACD Nationwide Outdoor Recreation Inventory, very few private and semiprivate commercial recreation enterprises operate in the county (*6*). They consist of two pay fishing lakes, a scout camp, a golf course, and a drive-in theater. The county committee responsible for preparing the inventory listed water sports and camping areas as the most pressing recreational needs in the county.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil

properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Nodaway is among 12 counties that make up the Northwest Prairie Zoogeographic Region in Missouri (*5*). The original vegetation in this region was 65 percent prairie and 35 percent woodland. Today, 72 percent of the county is classified as cropland. Of the two remaining vegetative cover types, about 17 percent of the acreage is grassland and 11 percent is woodland. The woodland percentage includes the nontree forms, such as shrubs and brushy species. A significant amount of woodland has been converted to cropland and grassland during the past 20 years. Both upland and bottom land forests are still being cleared. In certain parts of the county, grassland is being converted to row crops. The loss of wooded habitat to more intensive agricultural uses is the major problem affecting the wildlife resource. Also, wooded travelways within the field are lost when the size of the field is enlarged. In Nodaway County, the habitat is controlled by the private landowner, whose decisions on land use and management will determine the fate of the wildlife resource.

The songbird population is good in each of the soil associations described under the heading "General Soil Map Units." The furbearing population is good. Raccoon, coyote, muskrat, opossum, beaver, mink, striped skunk, badger, and red fox are the principal furbearing animals in the county. Prairie species, except for the badger, have all but disappeared because most of their original grassland habitat has been destroyed.

None of the soil associations are dominated by 50 percent or more wooded vegetation. The Nodaway-Colo-Zook association has the largest amount, 20 percent, of this scarce cover type. The remaining five associations add from 3 to 15 percent each to the total woodland base. Despite the scarcity of timber, the deer population is very good in the county. It has reached the habitat carrying capacity. Turkeys, which were first stocked in the early 1970's, remain low in number. They do best in the wooded areas along the Nodaway River. The fox squirrel population is good in the remaining timbered areas. The population of resident woodcocks is low, and the number of this species arriving in annual migratory flights is small.

All six soil associations provide openland wildlife habitat. About 89 percent of the land area is classified as cropland and grassland. The amount, quality, and interspersion of the scattered hardwood cover throughout these associations are the limiting cover type factors affecting those species that require hardwood cover for survival. The quail and rabbit population ranges from good to excellent in those parts of the county having a good mix of the three different cover types. The mourning dove requires very little woodland habitat, and

the resident population is good. Fair to good annual migratory flights raise the numbers of this game bird during the hunting season. Pheasant populations are good to excellent for a county in Missouri, and the birds appear to be increasing their range. The northwestern and southeastern parts of the county have the greatest concentration of pheasants.

Wetland habitat is extremely scarce in the county. It consists of certain old river cutoffs, or oxbows, and selected rivers and streams. The Nodaway-Colo-Zook association provides the remaining wetland habitat. Except for a limited number of resident wood ducks, all waterfowl within the county is considered to be migratory. Snow and blue geese from the Squaw Creek Wildlife Refuge in neighboring Holt County visit the western half of the county for feeding. A small number of Canada geese and mallards also visit certain ponds and rivers.

There are about 114 miles of perennial streams in the county (*4*). The Hundred and Two, Nodaway, and Platte Rivers provide the major public sport fisheries. All have undergone channel modification in the past. The principal river fishes are catfish, including the channel, flathead, and black bullhead. Large numbers of carp also are in the rivers.

Impoundment fishing is scarce in the county. Only the Nodaway Community Lake and Maryville City Reservoir offer public access for fishing. About 1,200 farm ponds and small lakes have been stocked with fish. Largemouth bass, channel catfish, and bluegill are the typical fish in the small impoundments. The Nodaway Community Lake has a population of northern pike, muskie, and crappie.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, soybeans, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface soil, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluegrass, switchgrass, orchardgrass, clover, alfalfa, indiangrass, birdsfoot trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, ragweed, beggarweed, foxtail, croton, and partridge pea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, sumac, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, persimmon, and sassafras. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are wild plum, hazelnut, Amur honeysuckle, autumn-olive, and crabapple.

Coniferous plants furnish winter cover, browse, and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, and cedar.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cutgrass, cattail, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, mourning dove, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the

limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and the shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction.

Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

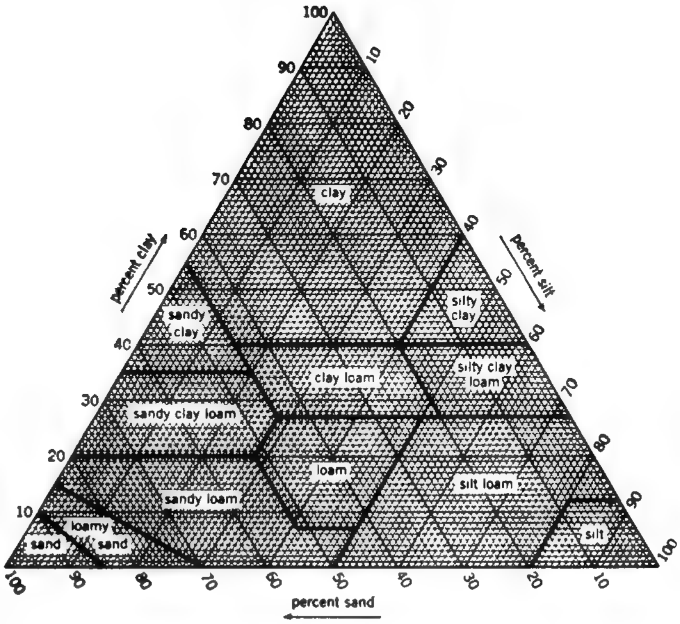

Figure 8.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 8). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2

millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after

rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*14*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*12*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*14*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Bremer Series

The Bremer series consists of deep, poorly drained soils on low stream terraces. These soils formed in silty alluvium. Permeability is moderately slow. Slopes range from 0 to 2 percent.

Bremer soils are similar to Colo soils and commonly are adjacent to Colo, Nevin, Wiota, and Zook soils. Colo soils have a lower content of clay than the Bremer soils, have a mollic epipedon 36 or more inches thick, and are on the lower flood plains. Nevin soils are somewhat poorly drained, contain less clay than the Bremer soils, and are in the slightly higher positions on terraces. Wiota

soils are moderately well drained and are in the higher terrace positions. Their argillic horizon is browner than that of the Bremer soils. Zook soils contain more clay in the B horizon than the Bremer soils and have a thicker mollic epipedon. They are on low flood plains.

Typical pedon of Bremer silty clay loam, 1,350 feet south and 1,200 feet west of the northeast corner of sec. 26, T. 66 N., R. 37 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; firm; neutral; gradual smooth boundary.

A—10 to 20 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Btg1—20 to 27 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine faint brown (10YR 4/3) and dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; very firm; distinct clay films; neutral; clear smooth boundary.

Btg2—27 to 41 inches; grayish brown (2.5Y 5/2) silty clay loam; few medium prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; very firm; few fine roots; few distinct clay films; few very dark gray streaks in root channels; few fine dark concretions of iron and manganese oxides; neutral; gradual smooth boundary.

Btg3—41 to 50 inches; gray (5Y 5/1) silty clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few distinct clay films; few very dark gray and gray streaks in root channels; few fine dark concretions of iron and manganese oxides; neutral; gradual smooth boundary.

Cg—50 to 60 inches; gray (5Y 5/1) silty clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; few dark gray streaks in root channels; few fine dark concretions of iron and manganese oxides; neutral.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is 24 to 36 inches thick. Reaction ranges from neutral to medium acid throughout the profile.

The A horizon has hue of 10YR or 2.5Y, value of 2, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay or silty clay loam in which the content of clay ranges from 36 to 40 percent. The C horizon has hue of 5Y to 10YR, value of 3 to 5, and chroma of 1.

Clarinda Series

The Clarinda series consists of deep, poorly drained soils on uplands. These soils formed in gray, clayey paleosols, which formed in glacial till. Permeability is very slow. Slopes range from 5 to 9 percent.

These soils have a thinner dark surface layer than is definitive for the Clarinda series. This difference, however, does not significantly affect the use or behavior of the soils.

Clarinda soils commonly are adjacent to Lamoni, Sharpsburg, and Shelby soils. Lamoni soils contain less clay and more sand than the Clarinda soils and are on lower side slopes. Sharpsburg soils are moderately well drained, contain less clay than the Clarinda soils, and are on higher ridgetops and side slopes. Shelby soils are moderately well drained, contain less clay than the Clarinda soils, and are on lower slopes.

Typical pedon of Clarinda silty clay loam, 5 to 9 percent slopes, eroded, 1,550 feet north and 50 feet west of the southeast corner of sec. 31, T. 62 N., R. 33 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

2Btg1—7 to 14 inches; dark gray (10YR 4/1) silty clay; few fine prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; medium acid; gradual smooth boundary.

2Btg2—14 to 21 inches; gray (5Y 5/1) clay; few fine prominent yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; firm; few slickensides; common prominent dark gray clay films on faces of peds; few white sand grains; neutral; gradual smooth boundary.

2Btg3—21 to 32 inches; olive gray (5Y 5/2) clay; few fine prominent brownish yellow (10YR 6/6) mottles; weak very fine subangular blocky structure; firm; few distinct clay films on faces of peds; few white sand grains; neutral; gradual smooth boundary.

2Btg4—32 to 54 inches; olive gray (5Y 5/2) clay; few fine prominent yellow (10YR 7/6) mottles; moderate fine subangular blocky structure; very firm; few distinct clay films on faces of peds; few black (10YR 2/1) organic stains; few fine and medium sand grains; neutral; gradual smooth boundary.

2C—54 to 60 inches; olive gray (5Y 5/2) clay; few medium prominent yellow (10YR 7/6) mottles; massive; very firm; few black (10YR 2/1) organic stains; few fine and medium sand grains; neutral.

The thickness of the solum ranges from 48 to more than 60 inches. Reaction ranges from medium acid to

neutral in the upper part of the profile and is neutral or mildly alkaline in the lower part.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is silty clay loam, but in some pedons it is silt loam or silty clay.

The 2Btg horizon has hue of 5Y, value of 5 or 6, and chroma of 1 or 2. It is clay or silty clay and is mottled with various shades of brown. The content of white fine sand increases with increasing depth.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils on the larger flood plains, on low stream terraces, and in upland drainageways. These soils formed in noncalcareous, silty sediments. Slopes range from 0 to 3 percent.

Colo soils are similar to Bremer and Zook soils and commonly are adjacent to Bremer, Kennebec, Nodaway, Shelby, and Zook soils. Bremer soils have a higher clay content than the Colo soils and have a B horizon. Kennebec and Nodaway soils are moderately well drained, contain less clay than the Colo soils, and are adjacent to the stream channel. Shelby soils contain more sand and gravel throughout than the Colo soils and are on upland side slopes. In the 10- to 40-inch control section of the Zook soils, the content of clay is more than 35 percent.

Typical pedon of Colo silty clay loam, 375 feet east and 150 feet south of the northwest corner of sec. 13, T. 64 N., R. 34 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

A1—6 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few fine roots; few soft iron and manganese accumulations; neutral; gradual smooth boundary.

A2—12 to 27 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; few fine roots; few soft iron and manganese accumulations; neutral; gradual smooth boundary.

A3—27 to 40 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine roots; few soft iron and manganese accumulations; neutral; gradual smooth boundary.

AC—40 to 52 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; few fine concretions of iron and manganese oxides; neutral; gradual smooth boundary.

Cg—52 to 60 inches; dark gray (10YR 4/1) silty clay loam; common medium prominent brown (10YR 4/3) and yellowish brown (10YR 5/4) and common medium distinct grayish brown (2.5Y 5/2) mottles; massive; firm; common dark grayish brown stains; common fine concretions of iron and manganese oxides; neutral.

The thickness of the solum ranges from 36 to 54 inches. The mollic epipedon is 36 or more inches thick. Some pedons have strata or overwash sediments 6 to 18 inches thick. Reaction is neutral or slightly acid throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It typically is silty clay loam, but in some pedons the Ap horizon is silt loam.

The Cg horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. Some pedons have sandy or gravelly horizons below a depth of 48 inches.

Gara Series

The Gara series consists of deep, moderately well drained soils on uplands. These soils formed in clay loam glacial till. Permeability is moderately slow. Slopes range from 14 to 20 percent.

Gara soils are similar to Ladoga and Shelby soils and commonly are adjacent to Ladoga, Pershing, and Shelby soils. Ladoga soils have more clay and less sand in the B horizon than the Gara soils. Pershing soils are somewhat poorly drained, have more clay than the Gara soils, and are on higher ridges. Shelby soils have a mollic epipedon.

Typical pedon of Gara loam, 14 to 20 percent slopes, eroded, 1,125 feet west and 125 feet south of the northeast corner of sec. 7, T. 64 N., R. 33 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

BA—5 to 10 inches; dark grayish brown (10YR 4/2) clay loam; strong medium subangular blocky structure; firm; few pebbles; medium acid; clear smooth boundary.

Bt1—10 to 16 inches; brown (10YR 4/3) clay loam, dark brown and brown (10YR 4/3) kneaded; moderate fine subangular blocky structure; firm; few distinct clay films on faces of peds; few pebbles and cobbles; strongly acid; clear smooth boundary.

Bt2—16 to 27 inches; yellowish brown (10YR 5/6) clay loam, brown (10YR 5/3) kneaded; few fine prominent gray (10YR 5/1) mottles; moderate medium subangular blocky structure; firm; few distinct clay films on faces of peds; few pebbles and cobbles; very strongly acid; gradual smooth boundary.

Bt3—27 to 36 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) kneaded; common fine prominent light olive gray (5Y 6/2) mottles; weak medium subangular blocky structure; firm; few distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; few pebbles and cobbles; neutral; clear smooth boundary.

C1—36 to 40 inches; yellowish brown (10YR 5/6) clay; massive; firm; few fine concretions of iron and manganese oxides; few fine soft calcium masses; few pebbles and cobbles; strongly effervescent; moderately alkaline; clear smooth boundary.

C2—40 to 60 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) clay loam; massive; firm; common coarse soft calcium masses in the lower part; few pebbles and cobbles; strongly effervescent; moderately alkaline.

The thickness of the solum ranges from 36 to 50 inches. The A horizon has hue of 10YR, value of 3, and chroma of 2. It dominantly is loam, but the range includes silt loam. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is medium acid or strongly acid. It is clay loam in which the content of clay ranges from 32 to 35 percent. The C horizon has hue of 10YR, value of 5 or 6, and chroma of 2 to 6.

Higginsville Series

The Higginsville series consists of deep, somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 9 percent.

These soils have a thinner dark surface layer than is definitive for the Higginsville series. This difference, however, does not significantly affect the use or behavior of the soils.

Higginsville soils are similar to Macksburg and Nevin soils and commonly are adjacent to Lamoni, Macksburg, Sharpsburg, and Shelby soils. Lamoni and Shelby soils have more sand and gravel than the Higginsville soils and are on lower side slopes. Macksburg soils have more clay than the Higginsville soils and are on broad ridges in the higher areas. The dark surface soil of Nevin soils is thicker than that of the Higginsville soils. Sharpsburg soils have more clay in the subsoil than the Higginsville soils and are on narrow ridgetops and side slopes in the higher areas.

Typical pedon of Higginsville silty clay loam, 5 to 9 percent slopes, eroded, 36 feet east and 2,630 feet south of the northwest corner of sec. 32, T. 65 N., R. 35 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; neutral; abrupt smooth boundary.

Bt1—8 to 12 inches; brown (10YR 4/3) silty clay loam; common fine prominent strong brown (7.5YR 5/6) mottles; moderate very fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bt2—12 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine prominent dark reddish brown (5YR 3/3) mottles; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; few fine concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Bt3—19 to 31 inches; grayish brown (10YR 5/2) silty clay loam; common fine faint brown (10YR 4/3) mottles; weak coarse subangular blocky structure parting to strong medium subangular blocky; firm; few distinct clay films on faces of peds; few fine concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Bt4—31 to 39 inches; grayish brown (10YR 5/2) silty clay loam; many fine distinct brownish yellow (10YR 6/6) and dark yellowish brown (10YR 4/6) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; slightly acid; gradual smooth boundary.

BC—39 to 53 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent brownish yellow (10YR 6/8) mottles; moderate coarse prismatic structure; firm; slightly acid; gradual smooth boundary.

C—53 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent brownish yellow (10YR 6/6) mottles; massive; firm; slightly acid.

The thickness of the solum ranges from 39 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 or 2. It ranges from slightly acid to strongly acid. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 1 or 2.

Kennebec Series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on flood plains adjacent to stream channels. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Kennebec soils commonly are adjacent to Colo and Nodaway soils. Colo soils have more clay throughout than the Kennebec soils and are somewhat lower on the flood plains. Nodaway soils are stratified throughout, do not have a mollic epipedon, and are adjacent to recently straightened stream channels.

Typical pedon of Kennebec silt loam, 2,300 feet west of the northeast corner of sec. 15, T. 63 N., R. 34 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular

structure; friable; very few fine roots; neutral; clear smooth boundary.

A1—6 to 11 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

A2—11 to 21 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

AC—21 to 31 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

C1—31 to 49 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

C2—49 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; massive; friable; neutral.

The thickness of the solum ranges from 31 to 58 inches. The mollic epipedon is more than 30 inches thick. Reaction is slightly acid or neutral throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is silt loam, but some pedons have loam overwash as much as 9 inches thick. The C horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. It is mottled with strong brown in some pedons.

Ladoga Series

The Ladoga series consists of deep, moderately well drained soils on loess-covered uplands and high terraces. These soils formed in silty loess. Permeability is moderately slow. Slopes range from 5 to 9 percent.

Ladoga soils are similar to Sharpsburg soils and commonly are adjacent to Gara, Kennebec, Pershing, and Sharpsburg soils. Gara soils contain more sand than the Ladoga soils, formed in glacial till, and are on the lower side slopes. Kennebec soils do not have a B horizon, have less clay than the Ladoga soils, and are on flood plains. Pershing soils are somewhat poorly drained, have more clay throughout than the Ladoga soils, and are on terraces and on the slightly higher side slopes. Sharpsburg soils have a mollic epipedon.

Typical pedon of Ladoga silt loam, 5 to 9 percent slopes, eroded, 1,150 feet west and 625 feet north of the southeast corner of sec. 1, T. 64 N., R. 34 W.

Ap—0 to 6 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium granular structure; friable; slightly acid; abrupt smooth boundary.

Bt1—6 to 16 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; medium acid; clear smooth boundary.

Bt2—16 to 25 inches; brown (10YR 4/3) silty clay loam; few fine faint dark yellowish brown (10YR 4/4) and few fine distinct grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; firm; few distinct clay films on faces of peds; few medium concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt3—25 to 41 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine prominent light brownish gray (2.5Y 6/2) mottles; moderate fine subangular blocky structure; firm; few distinct clay films on faces of peds; few medium concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

BC—41 to 60 inches; mottled dark yellowish brown (10YR 4/4) and grayish brown (2.5Y 5/2) silty clay loam; weak coarse subangular blocky structure; firm; gray (10YR 5/1) coatings on faces of peds; common medium concretions of iron and manganese oxides; slightly acid.

The solum typically is more than 60 inches thick. The A horizon is silt loam, but the range includes silty clay loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It ranges from strongly acid to slightly acid.

Lagonda Series

The Lagonda series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in loess or silty sediments and in the underlying weathered material that washed from glacial till. Slopes range from 5 to 9 percent.

These soils have a thinner dark surface layer than is definitive for the Lagonda series. This difference, however, does not significantly affect the use or behavior of the soils.

Lagonda soils are similar to Lamoni and Macksburg soils and commonly are adjacent to Clarinda, Lamoni, Macksburg, and Shelby soils. Clarinda soils are grayer than the Lagonda soils, contain more clay in the upper part of the argillic horizon, and are on slightly lower side slopes at the head of drainageways. Lamoni soils contain more sand and clay in the upper part of the argillic horizon than the Lagonda soils. In the solum of Macksburg soils, the content of sand is less than 5 percent. Shelby soils are moderately well drained, have more sand and less clay in the subsoil than the Lagonda soils, contain some pebbles and stones throughout, and are on the lower slopes.

Typical pedon of Lagonda silty clay loam, 5 to 9 percent slopes, eroded, 1,500 feet east and 200 feet

north of the southwest corner of sec. 22, T. 62 N., R. 34 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; neutral; abrupt smooth boundary.

BA—7 to 18 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

2Bt1—18 to 29 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; firm; common fine roots; few distinct clay films on faces of peds; mildly alkaline; gradual smooth boundary.

2Bt2—29 to 43 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine prominent yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; firm; common prominent clay films on faces of peds; mildly alkaline; gradual smooth boundary.

2Bt3—43 to 59 inches; light brownish gray (2.5Y 6/2) silty clay; common medium distinct dark yellowish brown (10YR 4/6) mottles; moderate coarse subangular blocky structure; very firm; few distinct clay films on faces of peds; mildly alkaline; clear smooth boundary.

2C—59 to 63 inches; light brownish gray (2.5Y 6/2) silty clay loam; many medium prominent yellowish brown (10YR 5/8) mottles; massive; very firm; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the loess ranges from 16 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is silty clay loam, but the range includes silt loam. The mollic epipedon extends into the upper part of the B horizon.

The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 or 2. It is silty clay or silty clay loam. It has mottles with hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 8. The B horizon is medium acid to neutral and the 2B horizon neutral or mildly alkaline.

The C horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is silty clay or silty clay loam.

Lamoni Series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in clayey and loamy paleosols. Slopes range from 5 to 14 percent.

These soils have a thinner solum and a higher pH in the lower part of the B horizon and the upper part of the C horizon than is definitive for the Lamoni series. Also, Lamoni clay loam, 9 to 14 percent slopes, eroded, has a thinner dark surface layer. These differences, however, do not significantly affect the use or behavior of the soils.

Lamoni soils are similar to Lagonda soils and commonly are adjacent to Clarinda, Lagonda, Sharpsburg, and Shelby soils. Clarinda soils have a gray silty clay and clay B horizon that is 3 or more feet thick. They are at the head of drainageways. Lagonda soils have less sand and clay in the upper part of the B horizon than the Lamoni soils. Sharpsburg soils do not have glacial sand and pebbles and are at the higher elevations on ridgetops and side slopes. Shelby soils have less clay than the Lamoni soils and typically are on lower side slopes.

Typical pedon of Lamoni clay loam, 5 to 9 percent slopes, 1,200 feet north and 900 feet west of the southeast corner of sec. 28, T. 64 N., R. 33 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A—7 to 12 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; friable; slightly acid; clear smooth boundary.

2BA—12 to 17 inches; olive brown (2.5Y 4/4) clay; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; dark grayish brown stains (10YR 4/2) on faces of peds; slightly acid; gradual smooth boundary.

2Bt1—17 to 26 inches; brown (10YR 4/3) clay; common fine distinct brown (7.5YR 4/4) and few fine faint dark grayish brown (10YR 4/2) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; many distinct clay films and few dark brown (10YR 3/3) organic coatings on faces of peds; neutral; gradual smooth boundary.

2Bt2—26 to 34 inches; coarsely mottled brown (10YR 5/3) and gray (10YR 5/1) clay; moderate medium subangular blocky structure; very firm; many prominent clay films on faces of peds; few small calcium masses at a depth of 33 inches; neutral; gradual smooth boundary.

2C1—34 to 43 inches; coarsely mottled dark yellowish brown (10YR 4/4), light brownish gray (2.5Y 6/2), and light olive brown (2.5Y 5/4) clay loam; massive; very firm; common soft calcium masses; mildly alkaline; strongly effervescent; diffuse smooth boundary.

2C2—43 to 60 inches; coarsely mottled grayish brown (2.5Y 5/2) and brown (10YR 5/3 and 7.5YR 4/4) clay loam; massive; very firm; common soft calcium

masses and hard calcium nodules less than 1/4 inch in diameter; mildly alkaline; strongly effervescent.

The thickness of the solum and the depth to free carbonates range from 34 to 48 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is clay loam, but the range includes silty clay loam. The Bt horizon has hue of 10YR, value of 3 to 6, and chroma of 2 to 6. It is clay loam or clay in which the content of clay ranges from 35 to 50 percent. It is medium acid to neutral. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is neutral or mildly alkaline.

Macksburg Series

The Macksburg series consists of deep, somewhat poorly drained soils on uplands and high stream terraces. These soils formed in silty loess. Permeability is moderately slow. Slopes range from 2 to 5 percent.

Macksburg soils are similar to Lagonda, Lamoni, and Pershing soils and commonly are adjacent to Clarinda, Lagonda, Lamoni, and Sharpsburg soils. Clarinda soils have more clay than the Macksburg soils, are grayer, and are in lower landscape positions at the head of drainageways. Lagonda and Lamoni soils contain more clay and sand than the Macksburg soils. Pershing soils do not have a mollic epipedon. Sharpsburg soils contain less clay in the Bt horizon than the Macksburg soils, are moderately well drained, and are on the lower side slopes or the slightly higher convex ridgetops.

Typical pedon of Macksburg silty clay loam, 2 to 5 percent slopes, 1,500 feet east and 125 feet south of the northwest corner of sec. 15, T. 64 N., R. 34 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

AB—7 to 12 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; dark gray (10YR 4/1) and very dark gray (10YR 3/1) coatings on faces of peds; few medium concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt1—12 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; strong fine subangular blocky structure; firm; common distinct clay films on faces of peds; very dark gray (10YR 3/1) coatings on faces of some peds and in root channels; neutral; clear smooth boundary.

Bt2—20 to 27 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common distinct dark clay films on faces of peds; very dark gray (10YR 3/1) coatings in root channels; few medium concretions of iron and manganese oxides; neutral; clear smooth boundary.

Bt3—27 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium prominent strong brown (7.5YR 4/6) mottles; moderate coarse subangular blocky structure; firm; common distinct clay films on faces of peds; neutral; clear smooth boundary.

BC—40 to 59 inches; olive gray (5Y 5/2) silty clay loam; few medium prominent dark yellowish brown (10YR 4/4) mottles; weak coarse subangular blocky structure; firm; neutral; gradual smooth boundary.

C—59 to 65 inches; gray (5Y 5/1) and olive gray (5Y 5/2) silty clay loam; few medium prominent dark yellowish brown (10YR 4/4) mottles; massive; firm; neutral.

The thickness of the solum ranges from 48 to more than 60 inches. The thickness of the mollic epipedon is 11 to 18 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It dominantly is silty clay loam, but in some pedons the Ap horizon is silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is neutral to medium acid. It dominantly is silty clay loam, but in some pedons it is silty clay. In the upper 20 inches of the argillic horizon, the content of clay ranges from 36 to 40 percent. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is neutral or slightly acid.

Nevin Series

The Nevin series consists of deep, somewhat poorly drained, moderately permeable soils on stream terraces. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Nevin soils are similar to Higginsville and Macksburg soils and commonly are adjacent to Bremer and Wiota soils. Bremer soils are grayer than the Nevin soils, have more clay, and are in somewhat lower landscape positions. The dark surface soil of Higginsville soils is thinner than that of the Nevin soils. Macksburg soils have more clay in the B horizon than the Nevin soils. Wiota soils have a B horizon that is browner than that of the Nevin soils and are in slightly higher landscape positions.

Typical pedon of Nevin silty clay loam, 1,600 feet north and 1,150 feet east of the southwest corner of sec. 23, T. 66 N., R. 37 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; friable; neutral; gradual smooth boundary.

A1—9 to 15 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and

medium granular structure; friable; slightly acid; gradual smooth boundary.

A2—15 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

Bt1—24 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak fine and very fine subangular blocky; firm; few very dark gray (10YR 3/1) organic coatings and clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—32 to 41 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine faint brown (10YR 4/3) and grayish brown (10YR 5/2) mottles; weak medium and coarse prismatic structure parting to weak very fine and fine subangular blocky; firm; few faint clay films and common very dark gray (10YR 3/1) organic coatings on faces of peds; medium acid; gradual smooth boundary.

Bt3—41 to 51 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common medium prominent yellowish brown (10YR 5/6) and common medium distinct grayish brown (10YR 5/2) mottles; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky; firm; few faint clay films on faces of peds; common coarse very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

C—51 to 60 inches; coarsely mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam; massive; very firm; common fine very dark grayish brown (10YR 3/2) clay flows and organic coatings in tubular pores; few fine and medium concretions of iron and manganese oxides; slightly acid.

The thickness of the solum ranges from 51 to more than 60 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is silty clay loam, but the range includes silt loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is medium acid to neutral. The content of clay in this horizon ranges from 32 to 36 percent. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 1 to 6.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Nodaway soils commonly are adjacent to Colo, Kennebec, and Olmitz soils. All of the adjacent soils have a mollic epipedon. Colo soils are poorly drained and are on the somewhat lower flood plains. Kennebec soils are in positions on the landscape similar to those of the Nodaway soils. Olmitz soils are on foot slopes or alluvial fans bordering upland drainageways.

Typical pedon of Nodaway silt loam, 1,750 feet north and 100 feet west of the southeast corner of sec. 17, T. 63 N., R. 33 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

C1—6 to 41 inches; stratified very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) silt loam, dark gray (10YR 4/1) and light brownish gray (10YR 6/2) dry; appears massive but has weak bedding planes; friable; few root channels; neutral; abrupt smooth boundary.

C2—41 to 60 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; appears massive but has weak bedding planes; firm; neutral.

The C horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The lighter colored layers contain more sand and coarse silt than the dark layers.

Olmitz Series

The Olmitz series consists of deep, moderately well drained, moderately permeable soils on foot slopes in the uplands. These soils formed in loamy alluvium derived from glacial till. Slopes range from 2 to 5 percent.

Olmitz soils are similar to Shelby soils and commonly are adjacent to Colo, Gara, Shelby, and Zook soils. Colo soils have a lower sand content than the Olmitz soils, have lower chroma below the A horizon, and are on flood plains, low terraces, and alluvial fans. Gara soils do not have a mollic epipedon and are higher on the landscape than the Olmitz soils. Shelby soils have an argillic horizon. Their mollic epipedon is thinner than that of the Olmitz soils. Zook soils contain more clay throughout than the Olmitz soils, have a sand content that is less than 15 percent, and are on low flood plains.

Typical pedon of Olmitz loam, 2 to 5 percent slopes, 1,470 feet west and 830 feet north of the southeast corner of sec. 14, T. 63 N., R. 34 W.

A1—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium angular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A2—8 to 18 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium angular blocky structure parting to weak fine and medium granular; friable; slightly acid; clear smooth boundary.

A3—18 to 27 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

Bw1—27 to 38 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

Bw2—38 to 49 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 4/3) kneaded, dark grayish brown (10YR 4/2) dry; few fine faint dark grayish brown (10YR 4/2) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; common very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual smooth boundary.

BC—49 to 60 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) kneaded, grayish brown (10YR 5/2) dry; few fine faint brown (10YR 4/3) mottles; weak fine and medium prismatic structure parting to weak medium subangular blocky; firm; common very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid.

The solum typically is more than 60 inches thick. Reaction is neutral or slightly acid throughout the profile.

The A and B horizons have hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The content of coarse sand and pebbles increases with increasing depth.

Pershing Series

The Pershing series consists of deep, somewhat poorly drained, slowly permeable soils on loess-covered uplands. These soils formed in loess. Slopes range from 5 to 9 percent.

Pershing soils are similar to Macksburg soils and commonly are adjacent to Gara, Kennebec, Ladoga, Macksburg, and Shelby soils. Gara and Shelby soils have more glacial sand and gravel than the Pershing soils, contain less clay, and are on lower side slopes. Kennebec soils do not have an argillic horizon, have less clay than the Pershing soils, and are on flood plains. Ladoga soils do not have a mollic epipedon and are browner than the Pershing soils. They are in positions on the landscape similar to those of the Pershing soils. Macksburg soils have a mollic epipedon.

Typical pedon of Pershing silt loam, 5 to 9 percent slopes, 1,000 feet east and 200 feet south of the northwest corner of sec. 1, T. 63 N., R. 34 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

E—9 to 16 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) and light gray (10YR 7/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium platy structure parting to weak medium subangular blocky; very friable; slightly acid; clear smooth boundary.

BE—16 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—25 to 35 inches; dark grayish brown (10YR 4/2) and brown (10YR 4/3) silty clay loam; few fine faint yellowish brown (10YR 5/4) mottles; moderate and strong medium subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—35 to 49 inches; coarsely mottled grayish brown (10YR 5/2), dark grayish brown (10YR 4/2), brown (10YR 5/3), and pale brown (10YR 6/3) silty clay loam; moderate medium prismatic structure parting to weak medium subangular blocky; firm; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—49 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; firm; few distinct clay films on faces of peds; neutral.

The thickness of the solum and the depth to carbonates are more than 60 inches. The Ap horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It dominantly is silt loam, but it is silty clay loam in some pedons. The E horizon has hue of 10YR, value of 4, and chroma of 1 or 2. It is strongly acid to slightly acid. The Bt horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 to 3. It is silty clay loam or silty clay. It ranges from neutral to strongly acid.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 2 to 9 percent.

Sharpsburg soils are similar to Ladoga soils and commonly are adjacent to Clarinda, Lamoni, and Shelby soils. Clarinda soils have more clay in the Bt horizon than the Sharpsburg soils and are at the head of draws in the lower concave areas. Ladoga soils do not have a mollic epipedon. Lamoni and Shelby soils have more glacial sand and gravel than the Sharpsburg soils and are in lower landscape positions.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, about 2,620 feet west and 700 feet north of the southeast corner of sec. 35, T. 65 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak very fine and fine granular structure; very friable; common fine roots; neutral; abrupt smooth boundary.

AB—8 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; friable; few fine roots; slightly acid; gradual smooth boundary.

Bt1—16 to 20 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; firm; few very fine roots; few distinct clay films; common dark brown (10YR 3/3) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

Bt2—20 to 28 inches; brown (10YR 4/3) silty clay loam; strong fine and medium subangular blocky structure; firm; few very fine roots; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—28 to 38 inches; brown (10YR 4/3) silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few very fine roots; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt4—38 to 46 inches; brown (10YR 4/3) silty clay loam; few fine distinct gray (10YR 5/1) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few very fine roots; few distinct dark brown (7.5YR 3/2) stains; few concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

BC—46 to 52 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct gray (10YR 5/1) mottles; weak medium and coarse prismatic structure; firm; few very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of most peds; few concretions of iron and manganese oxides; neutral; gradual smooth boundary.

C—52 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct gray (10YR 5/1) mottles; weak medium and coarse prismatic structure; firm; few very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; few concretions of iron and manganese oxides; neutral.

The thickness of the solum ranges from 42 to more than 60 inches. Reaction is slightly acid or neutral throughout the profile.

The Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is silty clay loam, but the range includes silt loam. The upper part of the B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The lower part has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. The content of clay in the Bt horizon is 36 to 42 percent. The BC and C horizons have hue of 10YR, 2.5Y, or 5Y. They have value of 4 or 5 and chroma of 4 or have value of 5 or 6 and chroma of 2. The C horizon is silty clay loam or silt loam.

Shelby Series

The Shelby series consists of deep, moderately well drained soils on uplands. These soils formed in glacial till. Permeability is moderately slow. Slopes range from 5 to 20 percent.

Shelby soils are similar to Gara and Olmitz soils and commonly are adjacent to Clarinda, Colo, Gara, Lamoni, and Sharpsburg soils. Clarinda and Lamoni soils are grayer than the Shelby soils, contain more clay in the B horizon, and are in the higher landscape positions. Colo soils have less glacial sand and gravel than the Shelby soils and are on flood plains adjacent to the uplands. Gara soils do not have a mollic epipedon. Olmitz soils do not have an argillic horizon. Their mollic epipedon is thicker than that of the Shelby soils. Sharpsburg soils have less glacial sand and gravel than the Shelby soils and are on ridgetops and upper side slopes on the higher parts of the landscape.

Typical pedon of Shelby loam, 9 to 14 percent slopes, about 1,100 feet west and 400 feet south of the northeast corner of sec. 19, T. 62 N., R. 33 W.

Ap—0 to 11 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

AB—11 to 18 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; a few brown (10YR 4/3) peds; weak fine subangular blocky structure; friable; common fine roots; very dark grayish brown (10YR 3/2) coatings on vertical faces of most peds; slightly acid; clear smooth boundary.

Bt1—18 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; firm; common fine roots; few distinct clay films on faces of peds; very dark grayish brown (10YR 3/2) vertical faces on some peds; few pebbles; medium acid; clear smooth boundary.

Bt2—28 to 37 inches; yellowish brown (10YR 5/4) clay loam; few fine faint brown (10YR 5/3) and few fine distinct light brownish gray (10YR 6/2) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; firm; few fine roots; few distinct clay films on faces of peds; few pebbles; medium acid; clear wavy boundary.

C—37 to 60 inches; yellowish brown (10YR 5/4) clay loam; light brownish gray (10YR 6/2) streaks and pockets; common fine and medium faint yellowish brown (10YR 5/6 and 5/8) mottles; massive; a few cleavage planes; firm; thin soft carbonate coatings on major cleavage planes; common fine and few

medium white calcium concretions and masses; few black stains; slightly effervescent; mildly alkaline.

The thickness of the solum ranges from 27 to 50 inches. The depth to free carbonates ranges from 30 to more than 60 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It dominantly is loam, but the range includes clay loam. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It ranges from neutral to strongly acid. The C horizon is slightly acid to moderately alkaline.

The eroded Shelby soils have a thinner dark surface layer than is definitive for the Shelby series. This difference, however, does not significantly affect the use or behavior of the soils.

Vanmeter Series

The Vanmeter series consists of moderately deep, moderately well drained soils on uplands. These soils formed in shale residuum. Permeability is very slow. Slopes range from 9 to 45 percent.

Vanmeter soils commonly are adjacent to Gara, Ladoga, and Shelby soils. Gara and Shelby soils are deep, contain glacial sand and pebbles, and are on the higher side slopes. Ladoga soils are deep, have an argillic horizon, and are on the higher side slopes and ridgetops.

Typical pedon of Vanmeter silt loam, 9 to 45 percent slopes, about 2,250 feet south and 500 feet west of the northeast corner of sec. 5, T. 65 N., R. 37 W.

A—0 to 4 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; few fine roots; neutral; clear smooth boundary.

Bw1—4 to 8 inches; olive brown (2.5Y 4/4) silty clay loam; moderate fine subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

Bw2—8 to 20 inches; olive brown (2.5Y 4/4) silty clay loam; moderate fine subangular blocky structure parting to moderate coarse platy; firm; neutral; gradual smooth boundary.

C—20 to 28 inches; light olive brown (2.5Y 5/4) silty clay loam; moderate very coarse platy structure; very firm; neutral; clear smooth boundary.

Cr—28 to 60 inches; olive (5Y 5/3) soft shale; strong very coarse platy rock structure; very firm; slightly effervescent; mildly alkaline.

The thickness of the solum ranges from 20 to 36 inches. The content of shale fragments ranges, by volume, from 0 to 10 percent throughout the A and B horizons.

The A horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. It dominantly is silt loam, but the range included silty clay loam. The B horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 to 4. It ranges from moderately alkaline to slightly acid. The C horizon has hue of 2.5Y or 5Y, value of 5, and chroma of 2 to 4.

Wiota Series

The Wiota series consists of deep, moderately well drained, moderately permeable soils on low stream terraces. These soils formed in silty alluvium washed from loess-covered uplands. Slopes range from 0 to 2 percent.

Wiota soils are similar to Nevin soils and commonly are adjacent to Bremer, Colo, Nevin, and Zook soils. Bremer soils are on the lower terraces. Their argillic horizon is grayer than that of the Wiota soils. Colo and Zook soils are on flood plains near the stream channel. Their mollic epipedon is thicker than that of the Wiota soils. The mottled B horizon of Nevin soils is grayer than that of the Wiota soils.

Typical pedon of Wiota silty clay loam, 2,640 feet south and 2,680 feet west of the northeast corner of sec. 26, T. 66 N., R. 37 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; very friable; neutral; clear smooth boundary.

A1—7 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A2—14 to 25 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—25 to 33 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

BA—33 to 44 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bt—44 to 53 inches; brown (10YR 4/3) silty clay loam; common fine prominent gray (10YR 5/1) mottles; moderate medium subangular blocky structure; friable; few faint clay films; slightly acid; gradual smooth boundary.

BC—53 to 60 inches; brown (10YR 4/3) silty clay loam; common fine distinct gray (10YR 5/1) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; slightly acid.

The thickness of the solum typically is more than 40 inches and ranges from 44 to more than 60 inches. The thickness of the mollic epipedon ranges from 21 to 48 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has chroma of 3 or 4.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on low flood plains. These soils formed in silty and clayey alluvium. Slopes are 0 to 1 percent.

Zook soils are similar to Colo soils and commonly are adjacent to Colo, Nodaway, Olmitz, and Shelby soils. Colo soils contain less clay than the Zook soils. Nodaway soils are browner than the Zook soils, have less clay, and commonly are in areas on the flood plain parallel to the river channel. Olmitz soils contain more sand throughout than the Zook soils and are on foot slopes. Shelby soils have glacial sand and gravel in the solum and are on upland side slopes.

Typical pedon of Zook silty clay loam, about 2,500 feet north and 275 feet west of the southeast corner of sec. 34, T. 64 N., R. 35 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A1—7 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine angular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

A2—16 to 22 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; firm; few fine roots; neutral; clear smooth boundary.

A3—22 to 31 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; common fine roots; neutral; clear smooth boundary.

AB—31 to 46 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate coarse subangular blocky structure; firm; neutral; clear smooth boundary.

Bg—46 to 57 inches; dark gray (10YR 4/1) silty clay; few fine distinct yellowish brown (10YR 5/4) mottles; moderate coarse subangular blocky structure; firm; black (10YR 2/1) streaks in root channels; neutral; gradual smooth boundary.

Cg—57 to 60 inches; dark gray (10YR 4/1) silty clay; massive; firm; neutral.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 36 to 50 inches. Reaction is neutral or slightly acid throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. It is silty clay loam or silty clay in which the content of clay ranges from 32 to 42 percent. The thickness of the A horizon ranges from 26 to 46 inches. The B and C horizons have hue of 10YR to 5Y, value of 3 or 5, and chroma of 1. They are silty clay or silty clay loam.

Formation of the Soils

Soil forms through processes that act on accumulated or deposited geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil that has distinct horizons. Although it varies, some time is always needed for differentiation of soil horizons. Generally, a long time is needed for distinct horizons to form. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the others.

Plants and Animals

Plants, burrowing animals, insects, bacteria, and fungi affect the formation of soils. They affect the organic matter content, plant nutrients, structure, and porosity of soils.

Many of the soils in Nodaway County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as prairie soils, have a thick, dark surface layer that has a high content of organic matter because of abundant bacteria and decayed fine grass roots. Soils that formed under this kind of plant cover included Bremer, Clarinda, Colo, Higginsville, Kennebec, Lagonda, Lamoni, Macksburg, Nevin, Olmitz, Sharpsburg, Shelby, Wiota, and Zook soils.

Soils that formed under forest vegetation have a surface layer that is thin and dark. An example is Vanmeter soils.

Gara, Ladoga, and Pershing soils have been influenced by grasses and trees. Generally known as transitional soils, they have properties intermediate between those of soils that formed under grasses and those of soils that formed under trees.

Worms, insects, burrowing animals, large animals, and human activities affect the soils. The effect of bacteria and fungi, which cause the rotting of organic material, improve tilth, and fix nitrogen in the soils, is greater than the effect of animals. The population of soil organisms is directly related to the rate of decomposition of organic material in the soils. The kinds of organisms in a given area and their activity are determined by differences in the vegetation.

Human activities have tremendously affected the soils in the county. Because of intensive cultivation and overgrazing, erosion has been severe on more than 227,000 acres. As much as 15 inches of topsoil has been lost from these areas. In many areas the soils are still eroding at a rate in excess of that which is tolerable if crop production is to be sustained.

Climate

Climate has been an important factor in the formation of the soils in Nodaway County. In the past 1 million years, variations in the climate have drastically affected the area.

Nodaway County has a subhumid, midcontinental climate that has changed little in the past 6,500 years. This period has been drier than previous ones and more favorable for native prairie grasses. Most of the soils have dark layers in the upper part of the profile, which indicates that the soils formed under prairie vegetation. Sharpsburg, Shelby, and Zook soils are examples.

The period between 6,500 years ago and 20,000 years ago was cool and moist. The climate was favorable for the growth of forest vegetation. Since that period, the forest vegetation has diminished, except in some areas near streams. Some soils in Nodaway County have a moderately thick, dark surface layer, which indicates that the soils formed under transitional prairie-timber vegetation. Gara, Ladoga, and Pershing soils are examples.

Changes in climate caused the glacial periods. Thousands of years of cool temperatures resulted in the massive glaciers of the Nebraska and Kansas ages. Warmer temperatures later resulted in severe geologic erosion and the blowing of the loess that covered most of Nodaway County at one time. Because extreme

changes in climate occurred very slowly there were long intermediate periods when different types of vegetation grew. Soils that formed on the surface were later covered by loess, truncated, and mixed by erosion or completely washed away. Some of the soils that formed mostly in these old truncated or weathered areas are Clarinda, Lagonda, and Lamoni soils.

The prevailing winds are from the southwest. As a result, most of the loess was blown in a northeasterly direction, probably from the flood plains along the Missouri River and other large streams. The distance that loess is carried by the wind depends on the size of the particles. Because most of the loess that covered Nodaway County was medium or fine silt and clay, the soils that formed in loess have a silty clay loam subsoil. Higginsville, Ladoga, Macksburg, and Sharpsburg soils are examples.

Local conditions can modify the influence of the general climate in a region. For example, south-facing slopes are warmer and drier than north-facing slopes, and low-lying, poorly drained soils on flood plains stay wetter and cooler for longer periods than the soils around them. These local differences affect the characteristics of the soils and account for some of the local differences among the soils.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. In Nodaway County, the soils formed in loess, glacial till, alluvium, or residual material or in a combination of these materials.

Loess is wind-deposited silty material. It probably was blown from the larger flood plains. Loess remains on most of the ridges and in many upper ends of drainageways. It is 14 feet thick in some areas. In Nodaway County, Higginsville, Ladoga, Macksburg, Pershing, and Sharpsburg soils formed in loess. Lagonda soils formed in a thin layer of loess and the underlying weathered sediments derived from glacial till.

Prior to the deposition of loess, thick layers of glacial till were deposited over bedrock. This glacial till generally is yellowish brown and is a heterogeneous mass of sand, silt, and clay material ranging in size from small pebbles to boulders. The glacial till ranges in thickness from a few feet to more than 300 feet. In some areas soils formed in the glacial till before the loess was deposited. In many of these areas the glacial material is exposed. The soils are generally in narrow areas, and the surface layer, which formed at a later time, varies in thickness. Clarinda and Lamoni are such soils. In the steeper areas the unweathered glacial material was exposed by geologic erosion at a later time. Gara and Shelby soils formed in this material.

Alluvium is soil material that was transported by water and deposited on the nearly level flood plains along streams. Most of this material came from the surrounding uplands. The material ranges from clay and silt to sand. Colo and Zook soils formed in the more clayey material, and Kennebec and Nodaway soils formed in the more silty material.

The residual material in Nodaway County weathered from calcareous shale beds. Vanmeter soils formed in residual material.

Relief

Relief affects soil formation mostly through its effect on drainage, runoff, and erosion.

The amount of water entering and passing through the soil depends on the slope, the permeability, and the amount and intensity of rainfall. Because runoff is rapid on steep soils, very little water passes through the soil material and the profile shows little evidence of the development of distinct horizons. Runoff is slow on gently sloping or nearly level soils, and most of the water passes through the soil material. The soils in these areas are characterized by maximum profile development. On similar slopes, soils that are rapidly permeable form more slowly than soils that are slowly permeable.

Generally, because they receive more direct sunrays, the soils on steep, south-facing slopes are more droughty than the soils on north-facing slopes. The droughtiness affects soil formation by influencing the amount and kind of vegetation that grows on the slope, susceptibility to erosion, and freezing and thawing.

Time

The degree of profile development is reflected by the length of time that the parent material has been in place and has been subject to weathering. Young soils show little evidence of profile development or horizon differentiation. Old soils show the effect of clay movement and leaching and have clear, distinct horizons.

Alluvial soils are the youngest soils in Nodaway County. Nodaway soils show no evidence of profile development because alluvial material is added to the surface nearly every year. Bremer soils are the oldest alluvial soils in the county. They are on the higher bottom lands and show moderate evidence of profile development.

Gara and Shelby soils are older than the alluvial soils in the county. They formed on dissected slopes of the Late Wisconsin-Recent age. The formation of these soils began probably 11,000 to 14,000 years ago (*9*). Higginsville, Lagonda, Pershing, Sharpsburg, Macksburg, and Ladoga soils formed in loess of Wisconsin age. The formation of these soils began probably 14,000 to 16,000 years ago.

The oldest soils in the county are Clarinda and Lamoni soils, which formed in glacial till of Kansas age. They

were partially truncated prior to the recent cycle of soil formation, more than 150,000 years ago (*8*).

In places in Nodaway County, rocky residual material has been exposed by geologic erosion. This residuum is very old, but the soils that formed in this material show little evidence of profile development because of the steep slopes and the limited depth. Vanmeter soils are an example.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is

not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the

surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in table). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified

organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size

measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depresions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces on blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seeding emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-79 at Maryville, Mo.]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	30.8	10.2	20.5	60	-19	0	0.72	0.15	1.16	2	7.0
February---	37.5	15.6	26.6	68	-15	10	1.08	.29	1.70	3	4.6
March------	47.7	25.2	36.5	81	-2	34	2.25	.74	3.47	5	3.9
April------	63.3	38.5	50.9	88	18	114	3.60	1.85	5.13	7	.6
May--------	74.1	50.2	62.2	92	30	388	4.54	2.87	6.04	8	.0
June-------	82.7	59.5	71.1	97	43	633	4.70	2.11	6.91	7	.0
July-------	87.5	63.9	75.7	101	48	797	4.05	1.47	6.19	6	.0
August-----	85.6	61.2	73.4	99	47	725	4.12	1.91	6.01	6	.0
September--	77.7	52.2	65.0	95	33	450	4.22	1.76	6.29	7	.0
October----	66.9	40.5	53.7	89	21	202	2.77	.82	4.36	5	.0
November---	50.5	27.9	39.2	76	5	12	1.71	.36	2.75	3	.9
December---	37.1	17.0	27.1	66	-10	0	1.06	.40	1.61	3	5.4
Yearly:											
Average--	61.8	38.5	50.2	---	---	---	---	---	---	---	---
Extreme--	---	---	---	102	-22	---	---	---	---	---	---
Total----	---	---	---	---	---	3,365	34.82	27.16	41.70	62	22.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-79 at Maryville, Mo.]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 22	April 27	May 9
2 years in 10 later than--	April 17	April 23	May 5
5 years in 10 later than--	April 7	April 16	April 27
First freezing temperature in fall:			
1 year in 10 earlier than--	October 16	October 7	September 27
2 years in 10 earlier than--	October 21	October 12	October 3
5 years in 10 earlier than--	October 31	October 21	October 14

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-79 at Maryville, Mo.]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	183	170	149
8 years in 10	191	176	156
5 years in 10	206	187	169
2 years in 10	221	199	182
1 year in 10	229	205	188

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
12E2	Gara loam, 14 to 20 percent slopes, eroded	2,100	0.4
13C2	Higginsville silty clay loam, 5 to 9 percent slopes, eroded	28,000	5.0
14C2	Lagonda silty clay loam, 5 to 9 percent slopes, eroded	13,600	2.4
15C	Lamoni clay loam, 5 to 9 percent slopes	56,500	10.1
15D2	Lamoni clay loam, 9 to 14 percent slopes, eroded	4,450	0.8
16B	Sharpsburg silty clay loam, 2 to 5 percent slopes	104,500	18.7
16C	Sharpsburg silty clay loam, 5 to 9 percent slopes	21,000	3.7
17C	Shelby loam, 5 to 9 percent slopes	14,200	2.5
17C2	Shelby clay loam, 5 to 9 percent slopes, eroded	40,250	7.2
17D	Shelby loam, 9 to 14 percent slopes	18,800	3.4
17D2	Shelby clay loam, 9 to 14 percent slopes, eroded	128,000	22.8
17E2	Shelby clay loam, 14 to 20 percent slopes, eroded	9,200	1.6
18C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded	880	0.2
19B	Macksburg silty clay loam, 2 to 5 percent slopes	7,800	1.4
20C2	Ladoga silt loam, 5 to 9 percent slopes, eroded	550	0.1
25C	Pershing silt loam, 5 to 9 percent slopes	540	*
40E	Vanmeter silt loam, 9 to 45 percent slopes	334	*
56B	Olmitz loam, 2 to 5 percent slopes	7,700	1.4
57	Wiota silty clay loam	860	0.2
58	Nevin silty clay loam	5,900	1.1
59	Bremer silty clay loam	3,350	0.6
90	Udorthents-Pits complex	327	*
99A	Colo silty clay loam, channeled, 0 to 3 percent slopes	17,100	3.1
100	Colo silty clay loam	20,250	3.6
101	Nodaway silt loam	24,000	4.3
104	Zook silty clay loam	19,100	3.4
105	Kennebec silt loam	8,700	1.6
	Water (less than 40 acres)	2,207	0.4
	Total	560,198	100.0

* Less than 0.1 percent

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
16B	Sharpsburg silty clay loam, 2 to 5 percent slopes
19B	Macksburg silty clay loam, 2 to 5 percent slopes
56B	Olmitz loam, 2 to 5 percent slopes
57	Wiota silty clay loam
58	Nevin silty clay loam
59	Bremer silty clay loam (where drained)
100	Colo silty clay loam (where drained)
101	Nodaway silt loam
104	Zook silty clay loam (where drained)
105	Kennebec silt loam (where protected from flooding or not frequently flooded during the growing season)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchardgrass-alfalfa hay	Orchardgrass-alfalfa	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
12E2------------ Gara	VIe	---	---	---	---	2.2	3.8	2.5
13C2------------ Higginsville	IIIe	103	39	94	43	4.6	9.2	4.3
14C2------------ Lagonda	IIIe	76	28	65	28	3.2	6.8	3.7
15C------------- Lamoni	IIIe	76	29	67	29	3.2	6.8	3.7
15D2------------ Lamoni	IVe	61	23	62	25	2.7	5.4	3.1
16B------------- Sharpsburg	IIe	113	43	92	46	4.7	9.9	4.2
16C------------- Sharpsburg	IIIe	108	41	89	45	4.6	9.5	4.1
17C------------- Shelby	IIIe	93	35	80	39	4.2	8.6	3.7
17C2------------ Shelby	IIIe	90	34	77	37	4.0	8.0	3.5
17D------------- Shelby	IIIe	84	32	75	35	3.7	7.4	3.3
17D2------------ Shelby	IVe	75	29	70	33	3.5	7.0	2.7
17E2------------ Shelby	VIe	---	---	---	---	2.6	5.0	1.7
18C2------------ Clarinda	IVe	55	21	50	25	2.7	5.4	2.3
19B------------- Macksburg	IIe	114	42	96	44	4.8	9.6	4.2
20C2------------ Ladoga	IIIe	95	37	85	38	4.3	8.6	3.9
25C------------- Pershing	IIIe	92	33	80	35	3.7	7.4	3.5
40E------------- Vanmeter	VIIe	---	---	---	---	---	---	1.0
56B------------- Olmitz	IIe	100	38	88	42	4.5	9.0	3.9
57-------------- Wiota	I	110	42	92	45	4.8	9.6	4.2
58-------------- Nevin	I	116	43	96	47	5.0	9.7	4.3
59-------------- Bremer	IIw	102	40	88	41	4.5	9.0	4.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-alfalfa hay	Orchard-grass-alfalfa	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
90**. Udorthents-Pits	---	---	---	---	---	---	---	---
99A. Colo	Vw	---	---	---	---	---	---	3.7
100. Colo	IIw	100	40	88	42	4.0	8.0	3.8
101. Nodaway	IIw	110	42	96	46	4.9	9.6	4.2
104. Zook	IIw	89	36	84	35	3.8	7.5	3.9
105. Kennebec	IIw	106	42	92	44	4.7	9.4	4.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
12E2. Gara	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, white oak, northern red oak.
20C2. Ladoga	3a	Slight	Slight	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, white oak, sugar maple, northern red oak, black walnut.
25C. Pershing	4c	Slight	Slight	Severe	Moderate	White oak	55	Eastern white pine, white oak.
40E. Vanmeter	5r	Severe	Severe	Severe	Moderate	White oak	45	Eastern white pine, eastern redcedar.
59. Bremer	3w	Slight	Severe	Moderate	Moderate	Eastern cottonwood Silver maple	90 80	American sycamore, hackberry, green ash, eastern cottonwood, silver maple.
101. Nodaway	2a	Slight	Slight	Slight	Slight	White oak Black walnut	75 76	Eastern white pine, black walnut.
105. Kennebec	2a	Slight	Slight	Slight	Slight	Black walnut Bur oak Hackberry Green ash Eastern cottonwood	79 63 --- --- ---	Black walnut, green ash, eastern cottonwood, American sycamore.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
12E2. Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern white-cedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
13C2. Higginsville	Lilac.	Amur honeysuckle, autumn-olive, Manchurian crab-apple, Siberian peashrub.	Eastern redcedar, Russian-olive, Austrian pine, jack pine, hackberry, green ash.	Honeylocust.	---
14C2. Lagonda	---	Amur honeysuckle, Washington hawthorn, Amur privet, arrowwood, eastern redcedar, Tatarian honey-suckle, American cranberrybush.	Austrian pine, osageorange, green ash.	Pin oak, eastern white pine.	---
15C, 15D2. Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
16B, 16C. Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
17C, 17C2, 17D, 17D2, 17E2. Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
18C2. Clarinda	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, Tatarian honey-suckle, American cranberrybush.	Green ash, osageorange, Austrian pine.	Eastern white pine, pin oak.	---
19B. Macksburg	---	American cranberrybush, Amur honeysuckle, Amur privet, silky dogwood.	Northern white-cedar, blue spruce, Washington hawthorn, white fir, Austrian pine.	Norway spruce.	Eastern white pine, pin oak.
20C2. Ladoga	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
25C: Pershing	---	Eastern redcedar, Tatarian honeysuckle, Washington hawthorn, Amur privet, Amur honeysuckle, arrowwood, American cranberrybush.	Austrian pine, osageorange, green ash.	Eastern white pine, pin oak.	---
40E: Vanmeter	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Honeylocust, northern catalpa, green ash, Russian-olive, bur oak, osageorange, black locust, eastern redcedar.	Siberian elm	---
56B: Olmitz	---	Amur maple, lilac, autumn-olive, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
57: Wiota	---	Lilac, Amur honeysuckle, autumn-olive, Amur maple.	Eastern redcedar, hackberry, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
58: Nevin	---	Amur honeysuckle, lilac, autumn-olive, Amur maple.	Eastern redcedar	Austrian pine, eastern white pine, honey-locust, hack-berry, green ash, pin oak.	Eastern cottonwood.
59: Bremer	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, honeylocust, green ash, silver maple, golden willow, northern red oak.	Eastern cottonwood.
90*: Udorthents.					
Pits.					
99A, 100: Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
101: Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
104----------------- Zook	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern white-cedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
105----------------- Kennebec	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Eastern redcedar	Austrian pine, hackberry, pin oak, green ash, honeylocust.	Eastern white pine, eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
12E2------------------ Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
13C2------------------ Higginsville	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
14C2------------------ Lagonda	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
15C------------------- Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
15D2------------------ Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
16B------------------- Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----------	Slight.
16C------------------- Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight.
17C, 17C2------------- Shelby	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight.
17D, 17D2------------- Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight----------	Moderate: slope.
17E2------------------ Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
18C2------------------ Clarinda	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
19B------------------- Macksburg	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
20C2------------------ Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight.
25C------------------- Pershing	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Slight----------	Slight.
40E------------------- Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, erodes easily.	Severe: slope.
56B------------------- Olmitz	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
57-------------------- Wiota	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
58-------------------- Nevin	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
59 Bremer	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
90*: Udorthents.					
Pits.					
99A Colo	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: flooding, wetness.	Severe: flooding.
100 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
101 Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
104 Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
105 Kennebec	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
12E2---------------- Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
13C2---------------- Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
14C2---------------- Lagonda	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
15C, 15D2----------- Lamoni	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
16B----------------- Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
16C----------------- Sharpsburg	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
17C, 17C2, 17D, 17D2--------------- Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
17E2---------------- Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
18C2---------------- Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
19B----------------- Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
20C2---------------- Ladoga	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
25C----------------- Pershing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
40E----------------- Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
56B----------------- Olmitz	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
57------------------ Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
58------------------ Nevin	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
59------------------ Bremer	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
90*: Udorthents.										
Pits.										
99A----------------- Colo	Fair	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
100----------------- Colo	Good	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
101----------------- Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Fair.
104----------------- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
105----------------- Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
12E2 Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
13C2 Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Moderate: wetness.
14C2 Lagonda	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
15C Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
15D2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
16B Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
16C Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
17C, 17C2 Shelby	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
17D, 17D2 Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
17E2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
18C2 Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
19B Macksburg	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
20C2 Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
25C Pershing	Severe: wetness.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
40E Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
56B------------- Olmitz	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
57-------------- Wiota	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
58-------------- Nevin	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
59-------------- Bremer	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
90*: Udorthents.						
Pits.						
99A------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Severe: flooding.
100------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
101------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
104------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
105------------- Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
12E2 Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
13C2 Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
14C2 Lagonda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
15C, 15D2 Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
16B Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
16C Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
17C, 17C2 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
17D, 17D2 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
17E2 Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
18C2 Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
19B Macksburg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
20C2 Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
25C Pershing	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
40E Vanmeter	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, hard to pack, slope.
56B Olmitz	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
57 Wiota	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
58 Nevin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
59 Bremer	Severe: percs slowly, flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness.
90*:					
Udorthents.					
Pits.					
99A, 100 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
101 Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
104 Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
105 Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
12E2: Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
13C2: Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
14C2: Lagonda	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
15C, 15D2: Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
16B, 16C: Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
17C: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
17C2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
17D: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
17D2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
17E2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
18C2: Clarinda	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
19B: Macksburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
20C2: Ladoga	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
25C: Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
40E: Vanmeter	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
56B: Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
57: Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
58: Nevin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
59------------------- Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
90*: Udorthents.				
Pits.				
99A, 100-------------- Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
101------------------- Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
104------------------- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
105------------------- Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
12E2 Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
13C2 Higginsville	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
14C2 Lagonda	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.
15C Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
15D2 Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
16B, 16C Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
17C, 17C2 Shelby	Moderate: slope.	Slight	Deep to water	Slope	Favorable	Favorable.
17D, 17D2, 17E2 Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
18C2 Clarinda	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
19B Macksburg	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Erodes easily, wetness.	Erodes easily.
20C2 Ladoga	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
25C Pershing	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Wetness, erodes easily.	Erodes easily, percs slowly.
40E Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, rooting depth.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
56B Olmitz	Moderate: seepage, slope.	Slight	Deep to water	Slope	Favorable	Favorable.
57 Wiota	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
58 Nevin	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
59 Bremer	Slight	Severe: wetness, hard to pack.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
90*: Udorthents.						
Pits.						
99A, 100 Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
101 Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
104 Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.
105 Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding	Favorable	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
12E2-------------- Gara	0-5	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	5-36	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	36-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
13C2-------------- Higginsville	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	15-20
	8-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	12-53	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	53-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-45	10-20
14C2-------------- Lagonda	0-7	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	7-18	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	18-59	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	40-70	25-40
	59-63	Silty clay loam, silty clay, clay loam.	CL, CH	A-7	0	95-100	90-100	80-95	75-90	45-60	25-40
15C, 15D2--------- Lamoni	0-12	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	12-34	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	34-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
16B, 16C---------- Sharpsburg	0-16	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	16-46	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	46-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
17C--------------- Shelby	0-18	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	18-37	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	37-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
17C2-------------- Shelby	0-8	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
17D--------------- Shelby	0-18	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	18-37	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	37-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
17D2, 17E2-------- Shelby	0-8	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-45	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	45-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
18C2-------------- Clarinda	0-7	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	7-21	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	21-60	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
19B--------------- Macksburg	0-12	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	12-40	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	40-65	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-50	20-30
20C2-------------- Ladoga	0-6	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	6-41	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	41-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
25C--------------- Pershing	0-16	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	16-25	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
	25-49	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	49-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
40E--------------- Vanmeter	0-4	Silt loam--------	CL, CL-ML	A-4, A-6	0-5	95-100	75-100	70-100	65-100	25-40	5-15
	4-28	Silty clay loam, clay loam.	CL, CH	A-7	0-5	95-100	75-100	70-100	65-100	40-55	15-30
	28-60	Weathered bedrock	CH	A-7	0-5	95-100	90-100	90-100	85-100	65-80	50-60
56B--------------- Olmitz	0-27	Loam-------------	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	27-60	Clay loam--------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
57---------------- Wiota	0-33	Silty clay loam	CL	A-6	0	100	100	100	90-95	30-40	10-20
	33-53	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	15-25
	53-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
58---------------- Nevin	0-24	Silty clay loam	CL, OL	A-6, A-7	0	100	100	100	90-95	35-45	10-20
	24-51	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
	51-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
59---------------- Bremer	0-20	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
	20-41	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	41-60	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40
90*: Udorthents.											
Pits.											
99A, 100---------- Colo	0-12	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	12-40	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	40-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
101--------------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
104--------------- Zook	0-22	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	22-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
105--------------- Kennebec	0-31	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	31-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
12E2	0-5	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate	0.28	5	6	2-3
Gara	5-36	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-7.3	Moderate	0.28			
	36-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
13C2	0-8	27-30	1.30-1.40	0.6-2.0	0.20-0.23	5.6-7.3	Moderate	0.37	4	6	1-3
Higginsville	8-12	27-35	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.37			
	12-53	27-35	1.40-1.50	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.37			
	53-60	25-30	1.50-1.60	0.6-2.0	0.18-0.22	5.1-6.5	Moderate	0.37			
14C2	0-7	27-32	1.35-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate	0.37	2	7	.5-2
Lagonda	7-18	27-35	1.35-1.50	0.2-0.6	0.18-0.20	5.6-6.5	Moderate	0.37			
	18-59	35-50	1.30-1.40	0.06-0.2	0.13-0.18	5.6-7.3	High	0.37			
	59-63	35-45	1.30-1.40	0.06-0.2	0.10-0.18	6.6-7.8	High	0.37			
15C, 15D2	0-12	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate	0.32	2	7	2-3
Lamoni	12-34	38-50	1.55-1.75	<0.2	0.13-0.17	5.1-6.5	High	0.32			
	34-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	5.6-7.3	High	0.32			
16B, 16C	0-16	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate	0.32	5	7	3-4
Sharpsburg	16-46	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate	0.43			
	46-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate	0.43			
17C	0-18	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate	0.28	5	6	3-4
Shelby	18-37	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28			
	37-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
17C2	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28	4	6	2-3
Shelby	8-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
17D	0-18	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate	0.28	5	6	3-4
Shelby	18-37	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28			
	37-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
17D2, 17E2	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28	4	6	2-3
Shelby	8-45	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate	0.28			
	45-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	0.37			
18C2	0-7	30-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate	0.37	3	7	.5-2
Clarinda	7-21	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-7.3	High	0.37			
	21-60	40-60	1.55-1.75	<0.06	0.14-0.16	5.6-7.3	High	0.37			
19B	0-12	25-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-7.3	Moderate	0.32	5	7	5-6
Macksburg	12-40	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-7.3	High	0.43			
	40-65	25-32	1.40-1.45	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
20C2	0-6	18-35	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low	0.32	5	6	2-3
Ladoga	6-41	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.5	Moderate	0.43			
	41-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.43			
25C	0-16	20-27	1.30-1.40	0.6-2.0	0.22-0.24	4.5-7.3	Low	0.37	3-2	6	2-3
Pershing	16-25	27-35	1.30-1.40	0.2-0.6	0.20-0.22	5.1-6.0	Moderate	0.37			
	25-49	35-48	1.35-1.45	0.06-0.2	0.18-0.20	5.1-6.0	High	0.37			
	49-60	24-40	1.35-1.50	0.2-0.6	0.18-0.20	5.1-6.5	High	0.37			
40E	0-4	18-24	1.30-1.40	0.2-0.6	0.18-0.20	6.1-8.4	Low	0.43	3	6	1-2
Vanmeter	4-28	27-40	1.30-1.40	0.2-0.6	0.14-0.16	6.1-8.4	Moderate	0.32			
	28-60	40-75	1.70-1.90	<0.06	0.08-0.10	7.4-8.4	High	----			
56B	0-27	24-30	1.40-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.28	5	6	3-4
Olmitz	27-60	28-34	1.45-1.55	0.6-2.0	0.15-0.17	5.1-6.5	Moderate	0.28			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
57----------------- Wiota	0-33	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	6	3-4
	33-53	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	53-60	28-34	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
58----------------- Nevin	0-24	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	4-6
	24-51	30-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43			
	51-60	25-36	1.40-1.45	0.6-2.0	0.18-0.20	6.6-7.3	Moderate-----	0.43			
59----------------- Bremer	0-20	25-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	5-7
	20-41	35-42	1.30-1.40	0.2-0.6	0.15-0.17	5.6-7.3	High---------	0.28			
	41-60	32-38	1.40-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High---------	0.28			
90*: Udorthents.											
Pits.											
99A, 100---------- Colo	0-12	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	12-40	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High---------	0.28			
	40-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
101---------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	2-3
104---------------- Zook	0-22	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	22-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
105---------------- Kennebec	0-31	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	5-6
	31-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
12E2 Gara	C	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
13C2 Higginsville	C	None	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High	Moderate	Moderate.
14C2 Lagonda	C	None	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High	High	Low.
15C, 15D2 Lamoni	C	None	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	Moderate	High	Moderate.
16B, 16C Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
17C, 17C2, 17D, 17D2, 17E2 Shelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
18C2 Clarinda	D	None	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High	High	Moderate.
19B Macksburg	B	None	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High	High	Moderate.
20C2 Ladoga	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
25C Pershing	C	None	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	High	High	Moderate.
40E Vanmeter	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
56B Olmitz	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
57 Wiota	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
58 Nevin	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Low.
59 Bremer	C	Occasional	Very brief	Nov-May	1.0-2.0	Apparent	Nov-Jul	>60	---	High	Moderate	Moderate.
90*: Udorthents.												

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
90*: Pits.												
99A---------------- Colo	B/D	Frequent----	Very brief to long.	Nov-May	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
100---------------- Colo	B/D	Occasional	Very brief to long.	Nov-May	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
101---------------- Nodaway	B	Occasional	Very brief to brief.	Nov-May	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
104---------------- Zook	C/D	Occasional	Brief to long.	Nov-May	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
105---------------- Kennebec	B	Frequent----	Brief-----	Nov-May	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
*Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
*Lagonda	Fine, montmorillonitic, mesic Aquic Argiudolls
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Pershing	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Udorthents	Mixed, mesic Typic Udorthents
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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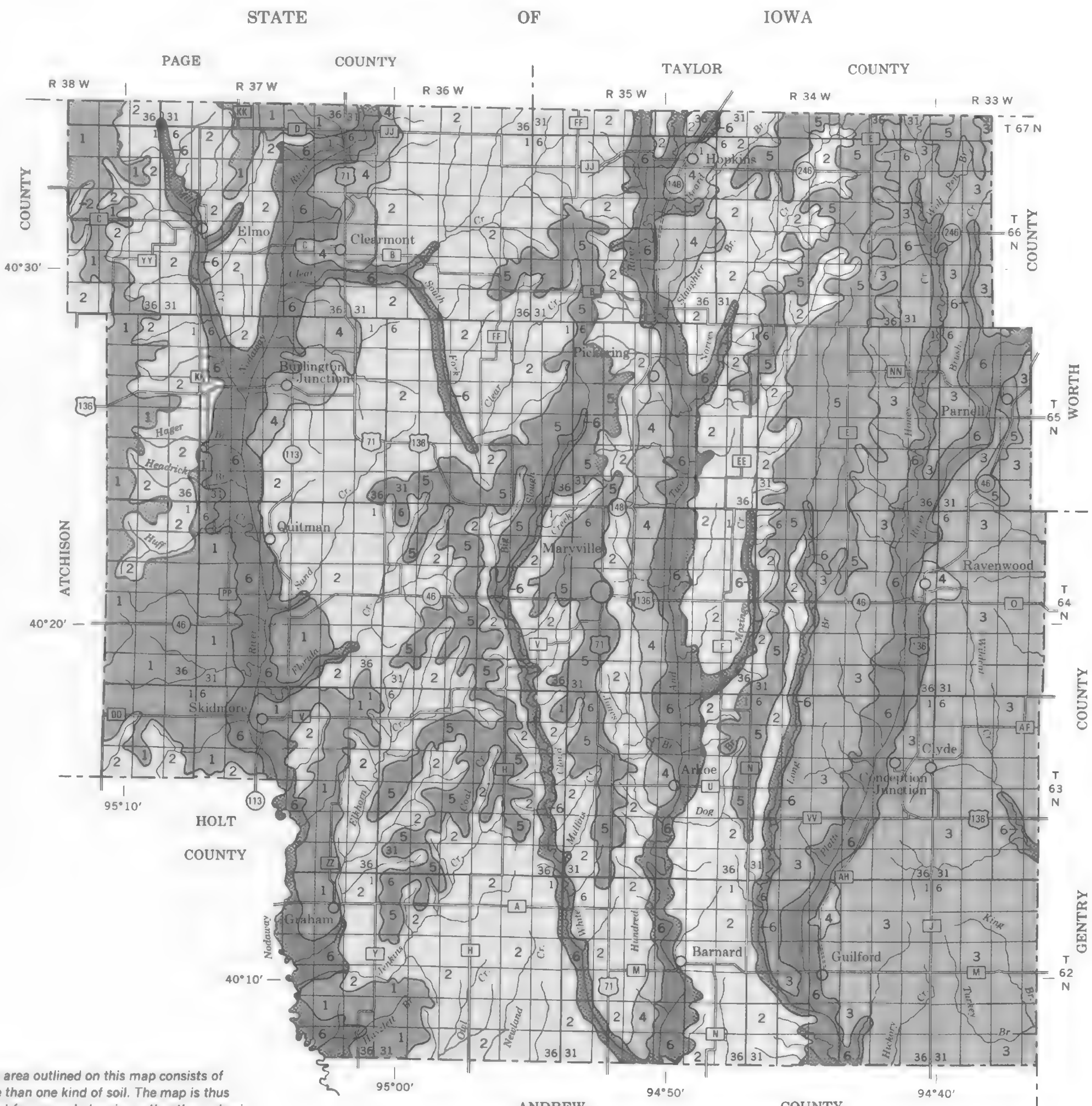

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

LEGEND

1	SHARPSBURG-SHELBY association: Gently sloping to moderately steep, moderately well drained soils formed in loess and glacial till; on uplands
2	SHELBY-SHARPSBURG-LAMONI association: Gently sloping to moderately steep, moderately well drained and somewhat poorly drained soils formed in glacial till and loess; on uplands
3	SHELBY-LAMONI association: Moderately sloping to moderately steep, moderately well drained and somewhat poorly drained soils formed in glacial till; on uplands
4	SHARPSBURG-HIGGINSVILLE-NEVIN association: Nearly level to moderately sloping, moderately well drained and somewhat poorly drained soils formed in loess and silty alluvium; on uplands and stream terraces
5	SHARPSBURG-HIGGINSVILLE-MACKSBURG association: Gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils formed in loess; on uplands
6	NODAWAY-COLO-ZOOK association: Nearly level, moderately well drained and poorly drained soils formed in silty and clayey alluvium; on flood plains and low terraces

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N

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SOIL CONSERVATION SERVICE
MISSOURI AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

NODAWAY COUNTY, MISSOURI

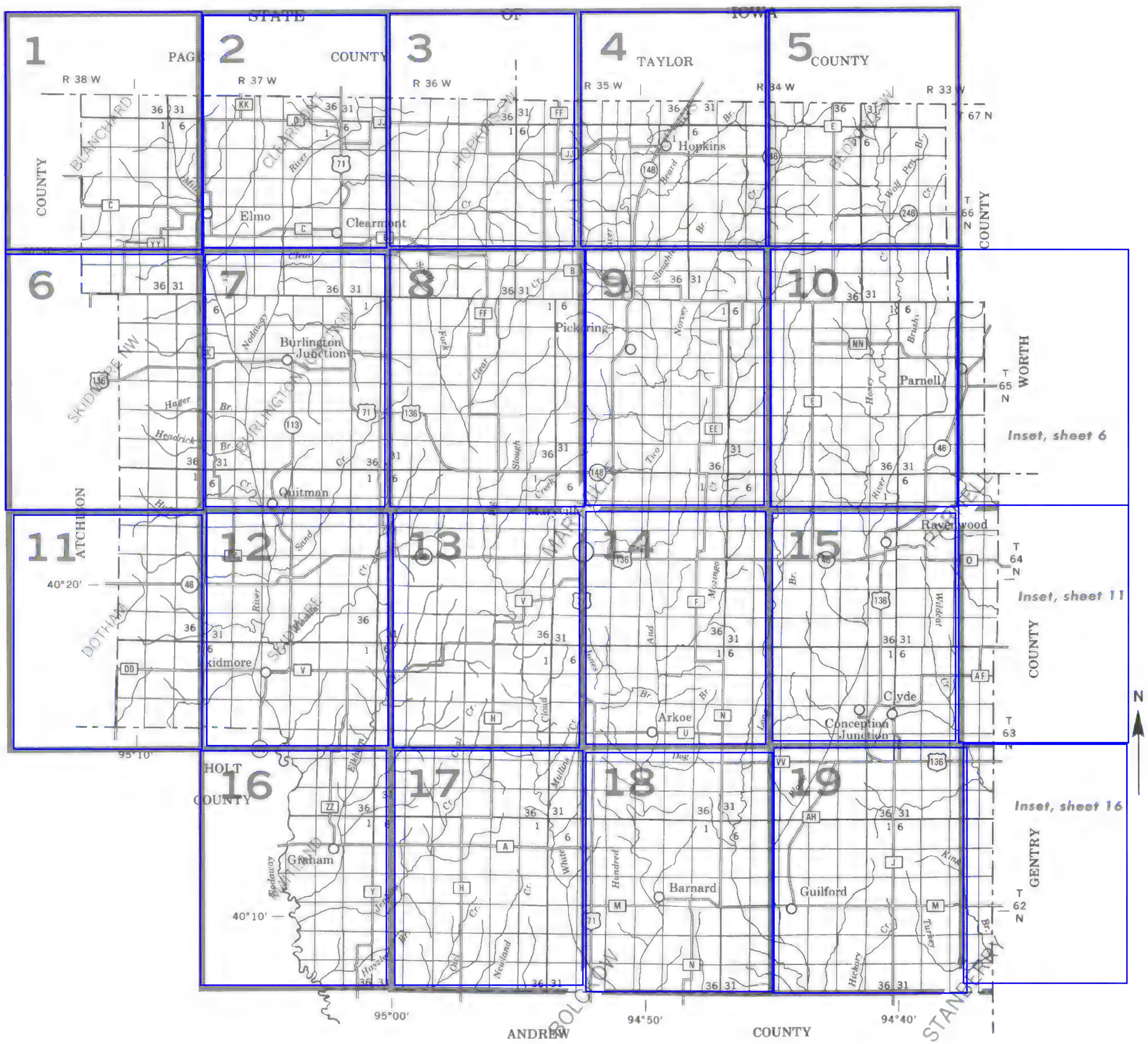
Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36



General Soil Map

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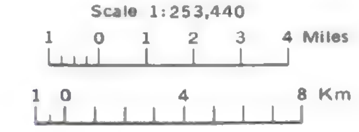
Legend

INDEX TO MAP SHEETS

NODAWAY COUNTY, MISSOURI

Scale 1:253,440



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is eroded.

SYMBOL	NAME
12E2	Gara loam, 14 to 20 percent slopes, eroded
13C2	Higginsville silty clay loam, 5 to 9 percent slopes, eroded
14C2	Lagonda silty clay loam, 5 to 9 percent slopes, eroded
15C	Lamoni clay loam, 5 to 9 percent slopes
15D2	Lamoni clay loam, 9 to 14 percent slopes, eroded
16B	Sharpsburg silty clay loam, 2 to 5 percent slopes
16C	Sharpsburg silty clay loam, 5 to 9 percent slopes
17C	Shelby loam, 5 to 9 percent slopes
17C2	Shelby clay loam, 5 to 9 percent slopes, eroded
17D	Shelby loam, 9 to 14 percent slopes
17D2	Shelby clay loam, 9 to 14 percent slopes, eroded
17E2	Shelby clay loam, 14 to 20 percent slopes, eroded
18C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded
19B	Macksburg silty clay loam, 2 to 5 percent slopes
20C2	Ladoga silt loam, 5 to 9 percent slopes, eroded
25C	Pershing silt loam, 5 to 9 percent slopes
40E	Vanmeter silt loam, 9 to 45 percent slopes
56B	Olmitz loam, 2 to 5 percent slopes
57	Wiota silty clay loam
58	Nevin silty clay loam
59	Bremer silty clay loam
90	Udorthents-Pits complex
99A	Colo silty clay loam, channeled, 0 to 3 percent slopes
100	Colo silty clay loam
101	Nodaway silt loam
104	Zook silty clay loam
105	Kennebec silt loam

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CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

- Federal — 136
- State — 46
- County — Y

ROADS

- Divided (median shown if scale permits)
- Other roads

RAILROAD

DAMS

- Large (to scale)
- Medium or small — water

PITS

- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Church
- School

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Canals or ditches
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 56B 25C

MISCELLANEOUS

- Rock outcrop (includes sandstone and shale)
- Sandy spot
- Sewage Lagoon — (label)

Scale 1:24000

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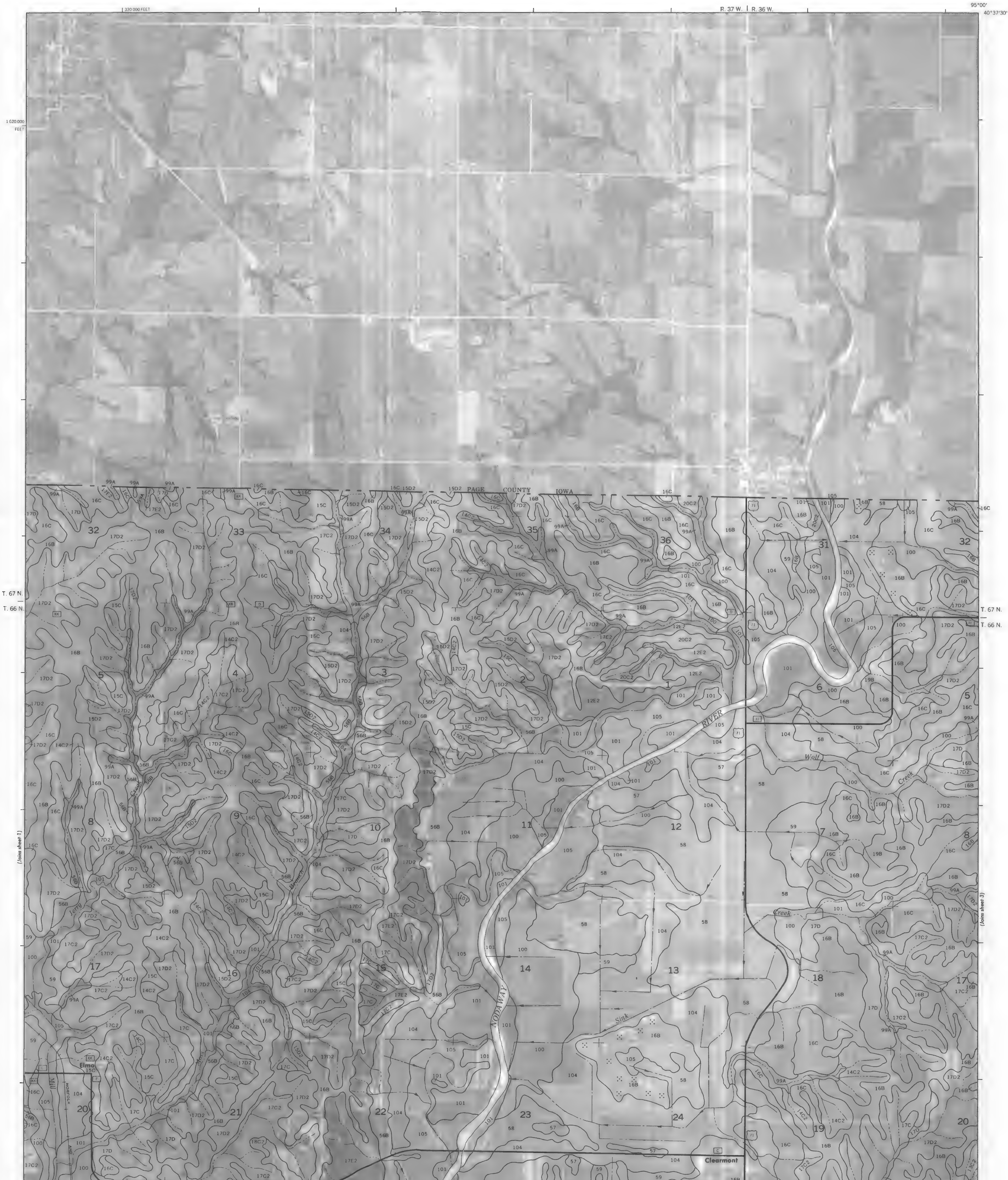
Orthophoto compiled from 1975 aerial photography by the U.S. Department of the Interior, Geological Survey.



Scale 1:24000
1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet

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1 ½ ¼ ¾ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
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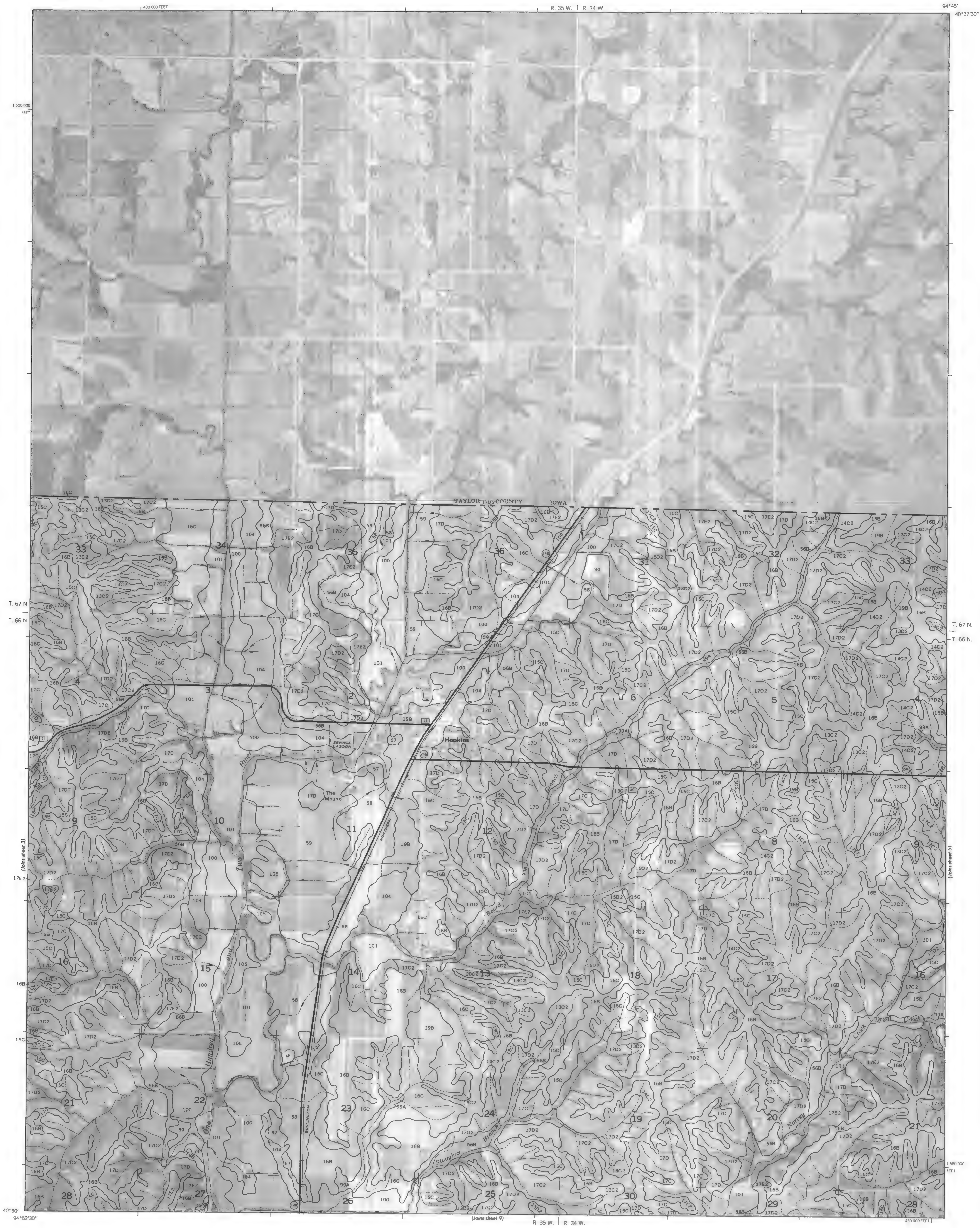

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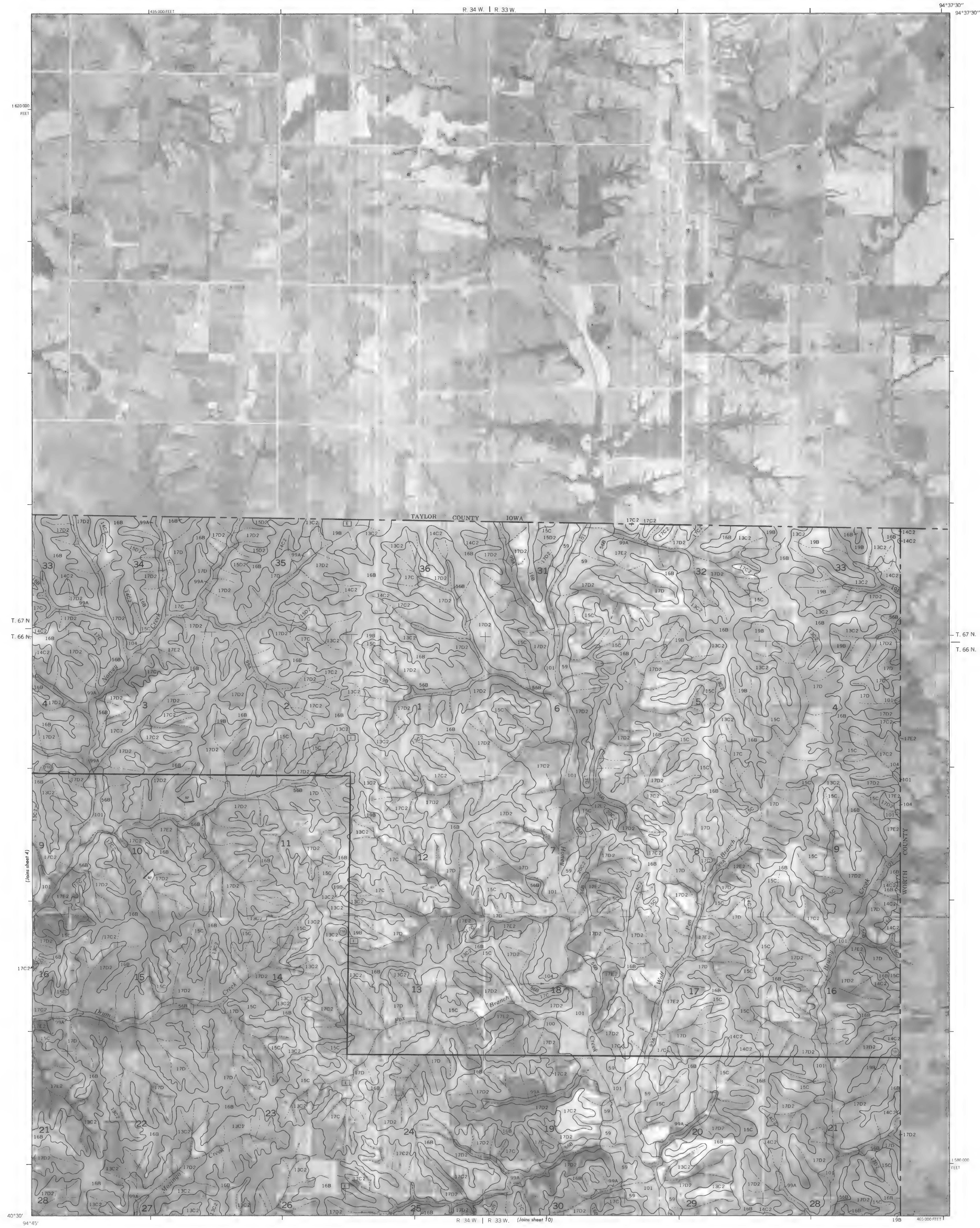

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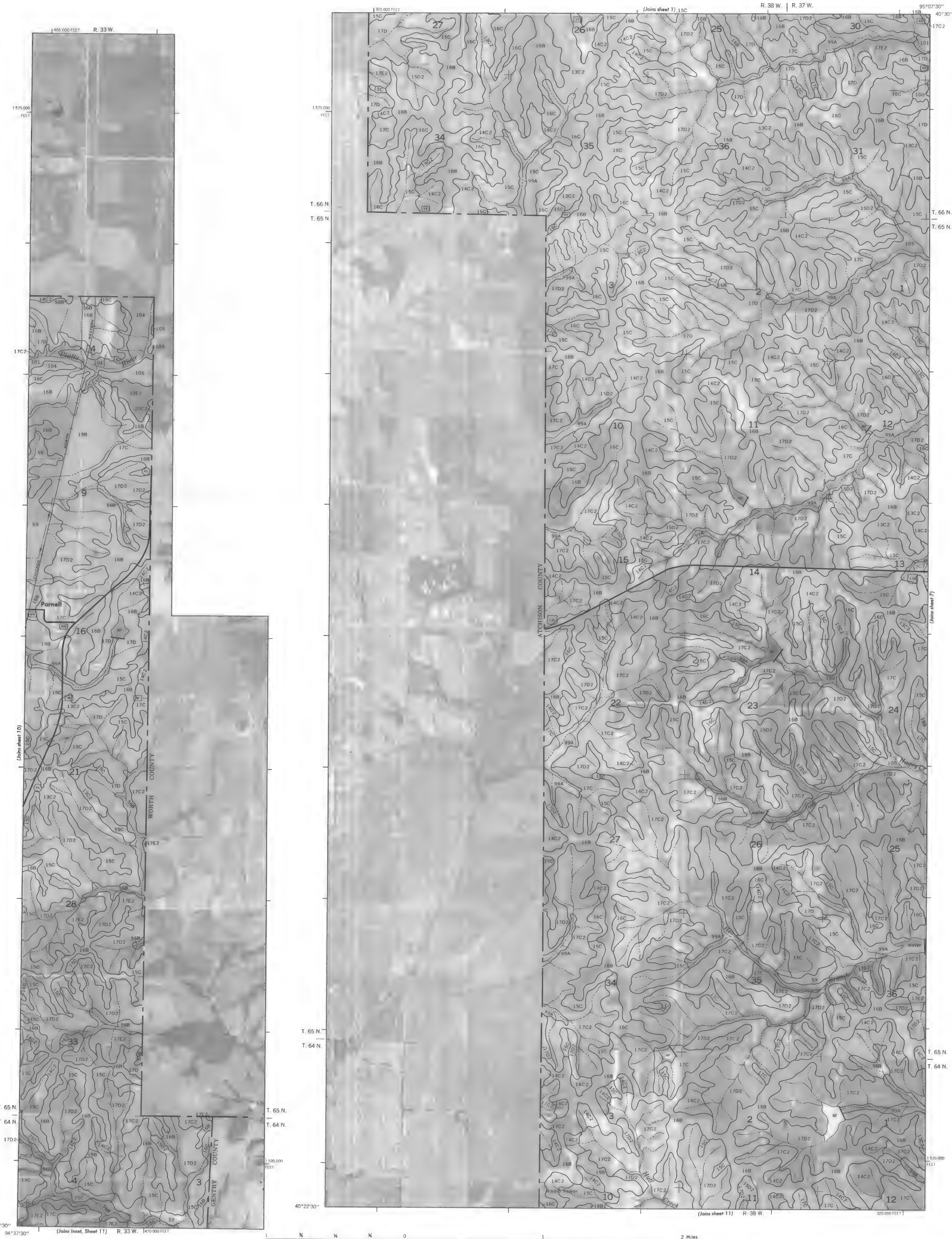

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SOIL CONSERVATION SERVICE

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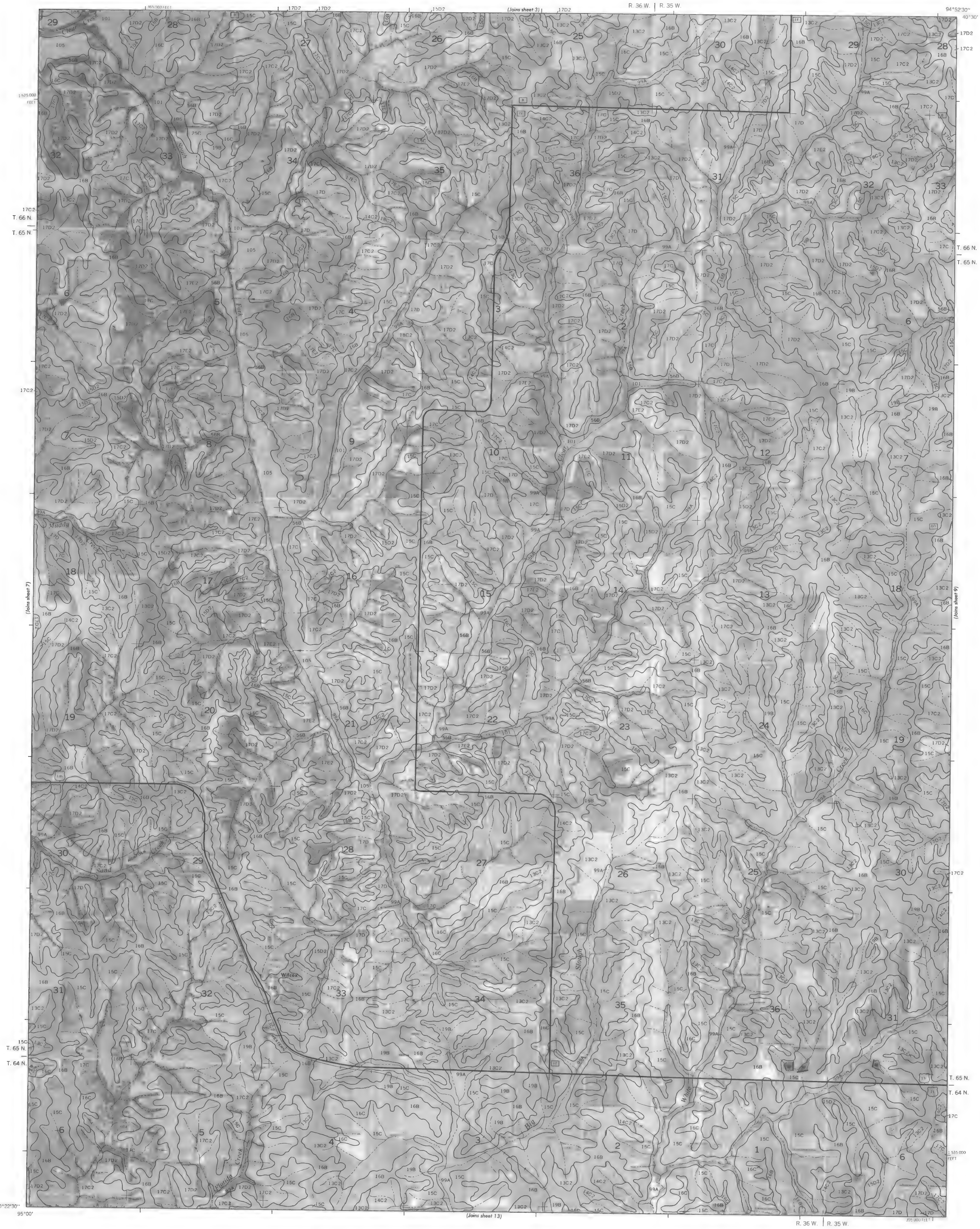
SHEET NO. 8
NODAWAY COUNTY, MISSOURI
(NORTHWEST MARYVILLE QUADRANGLE)



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SOIL CONSERVATION SERVICE

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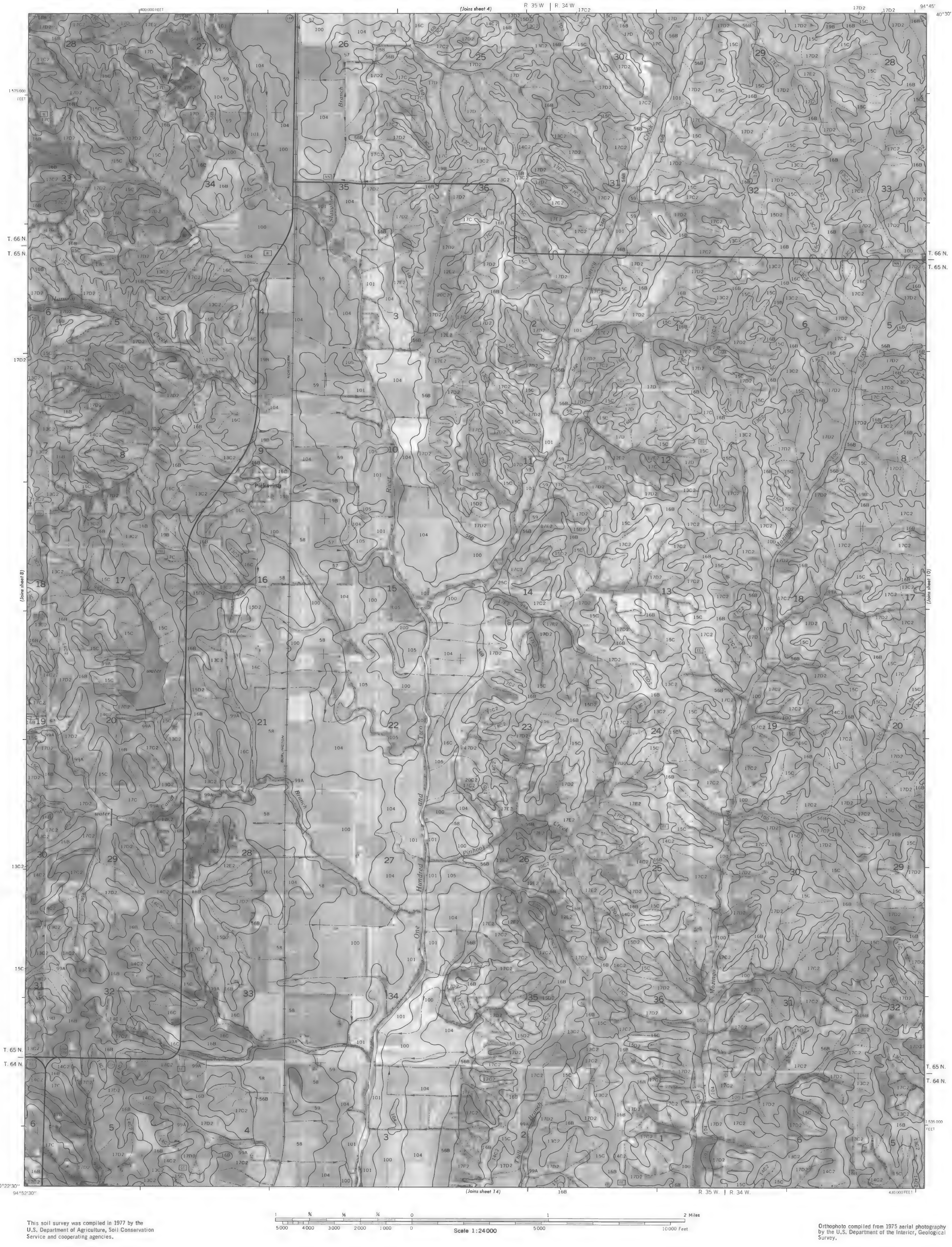

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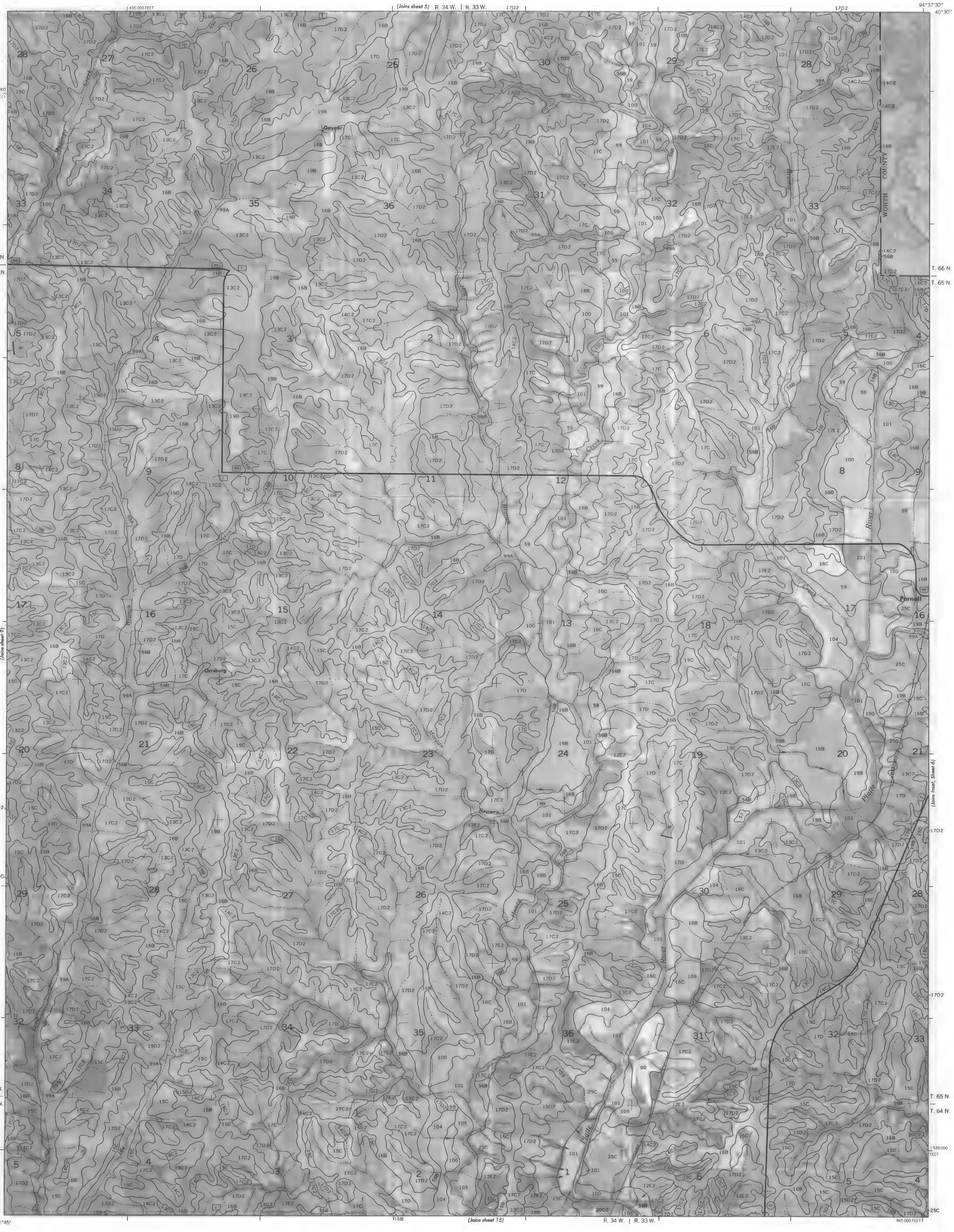

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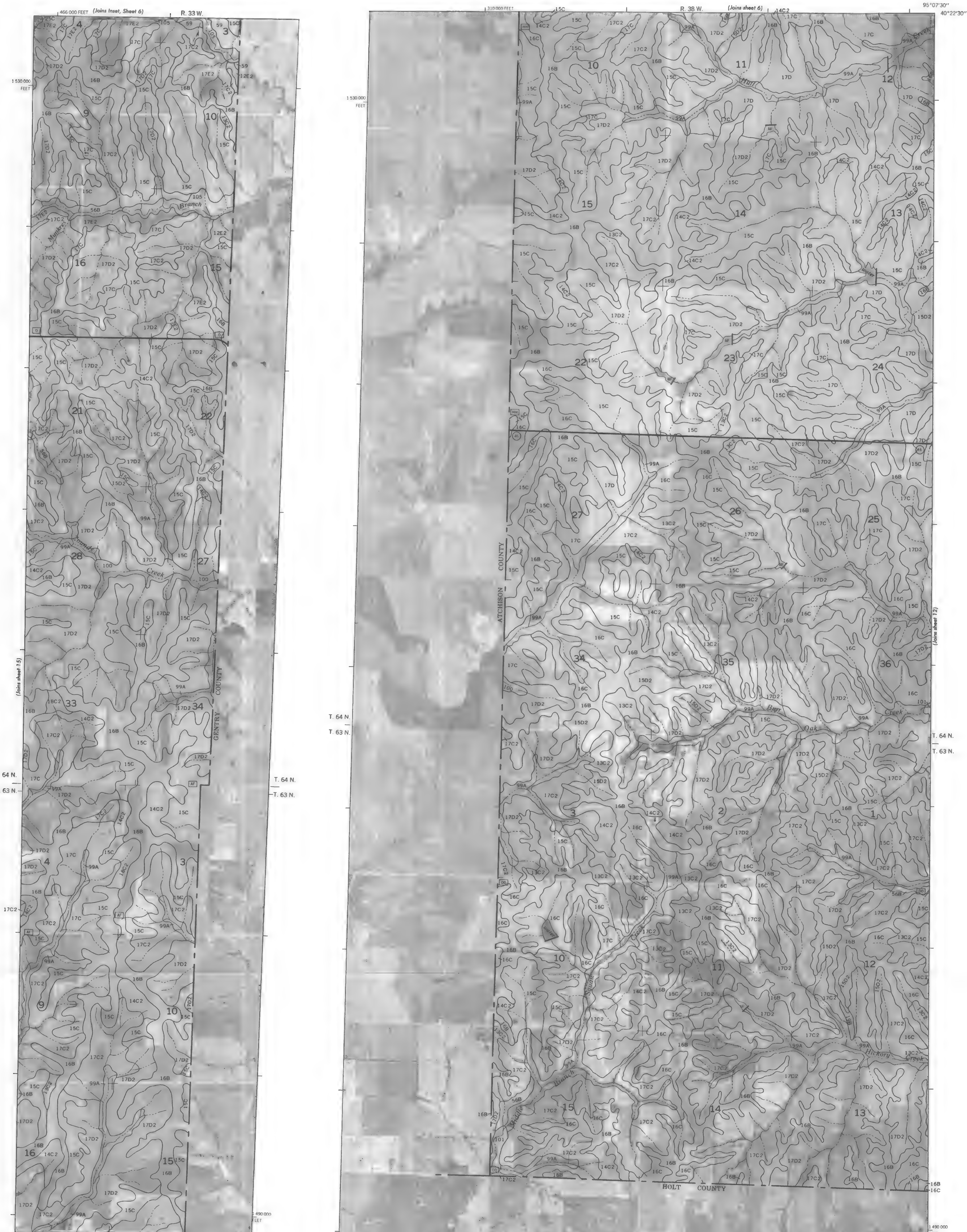

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1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

Scale 1:24000

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SHEET NO. 12
NODAWAY COUNTY, MISSOURI
(SKIDMORE QUADRANGLE)

1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

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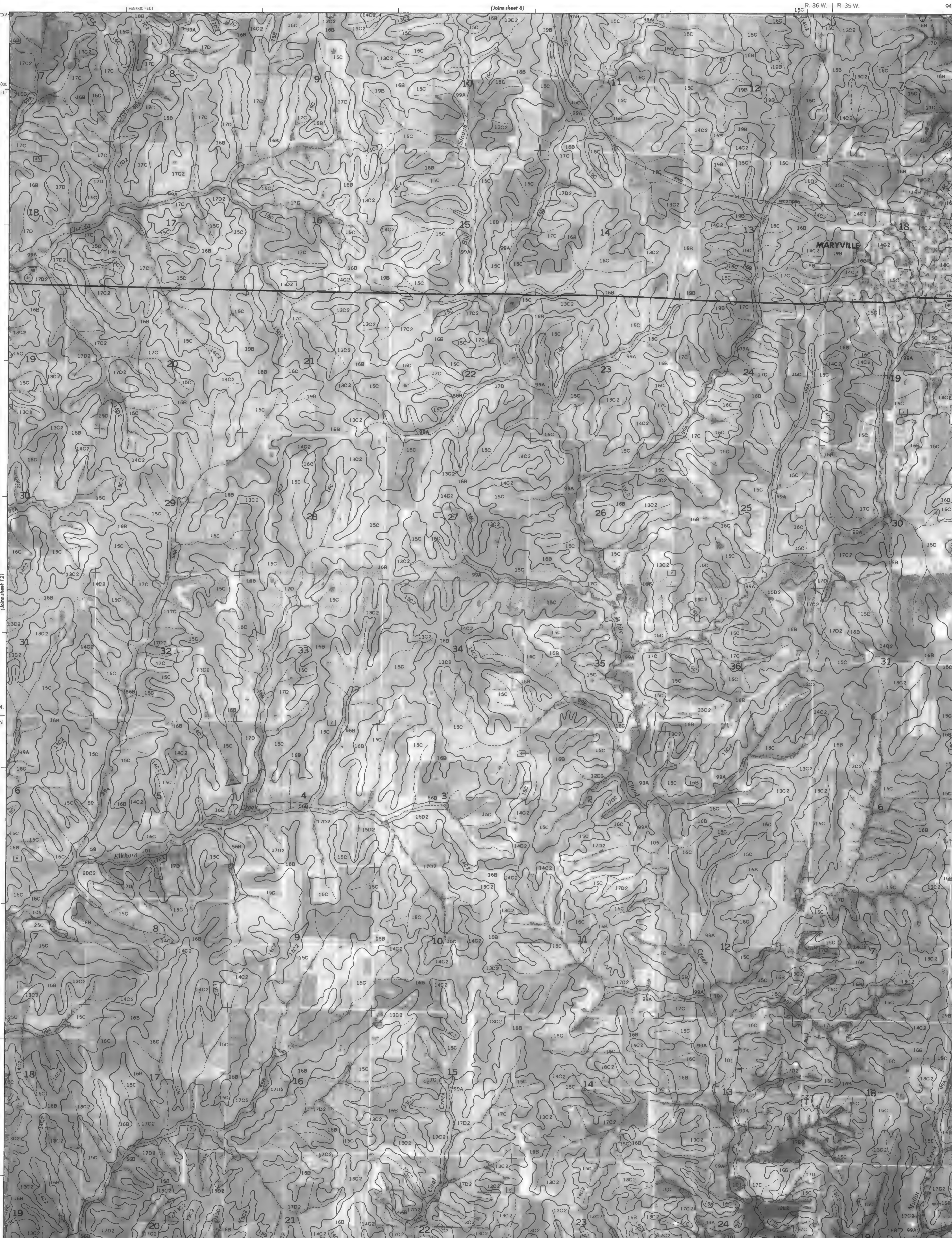
NODAWAY COUNTY, MISSOURI NO. 12



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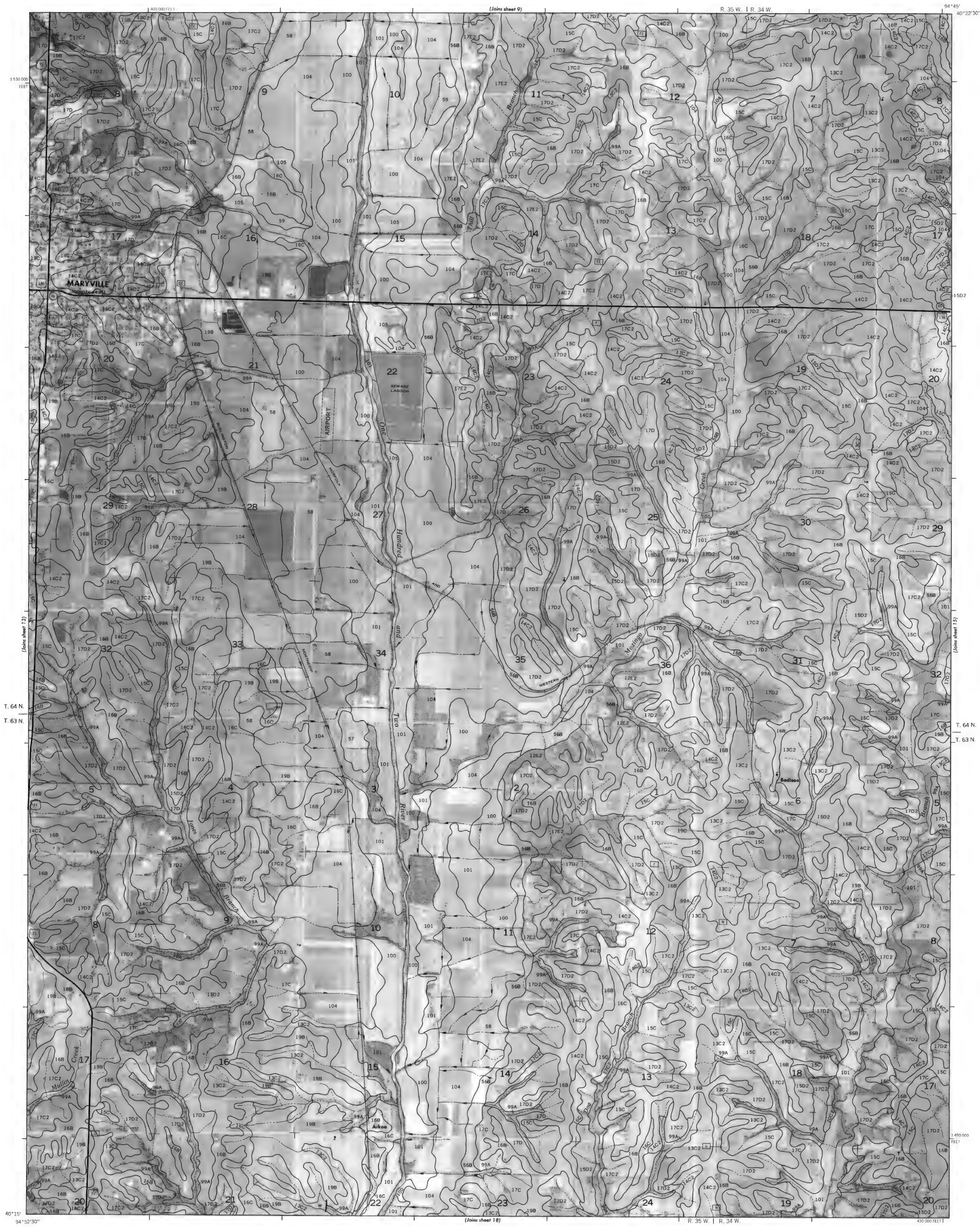
SHEET NO. 14
NODAWAY COUNTY, MISSOURI
(SOUTHEAST MARYVILLE QUADRANGLE)



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SHEET NO. 15
NODAWAY COUNTY, MISSOURI
(SOUTHWEST PARNELL QUADRANGLE)

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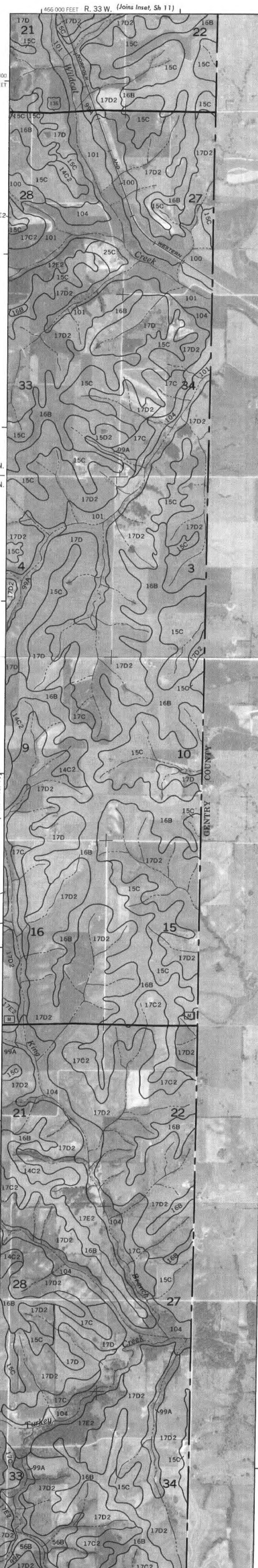

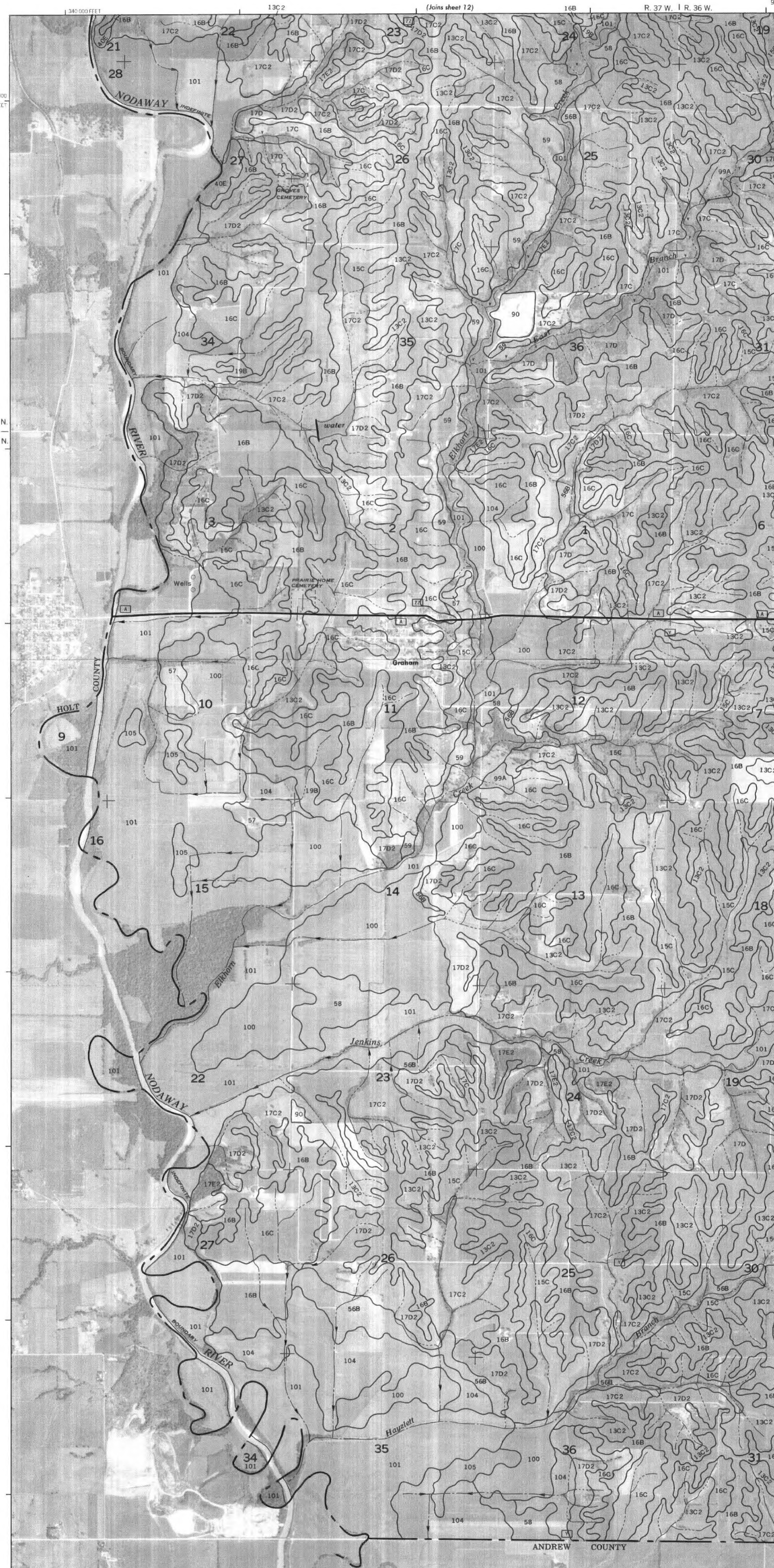

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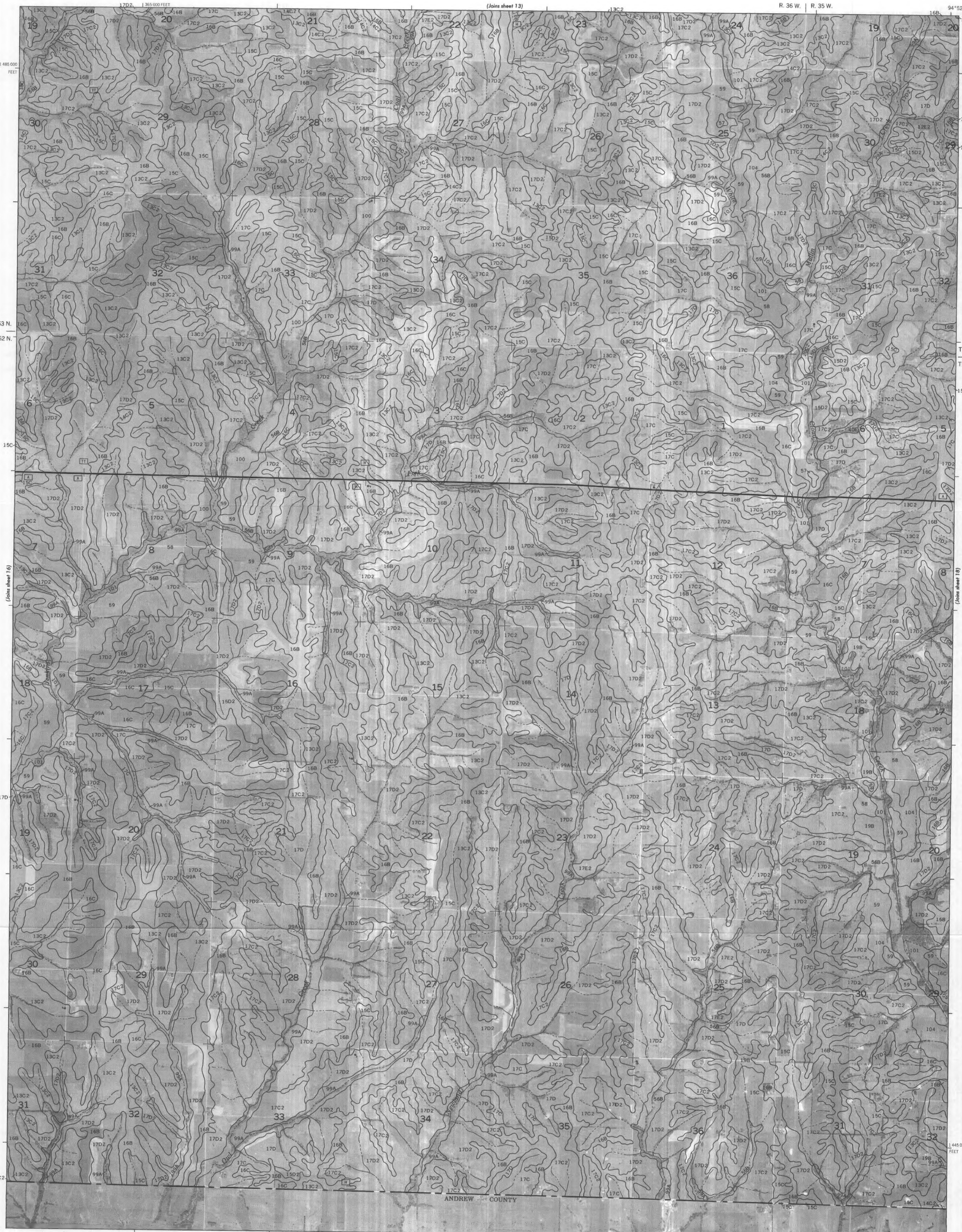

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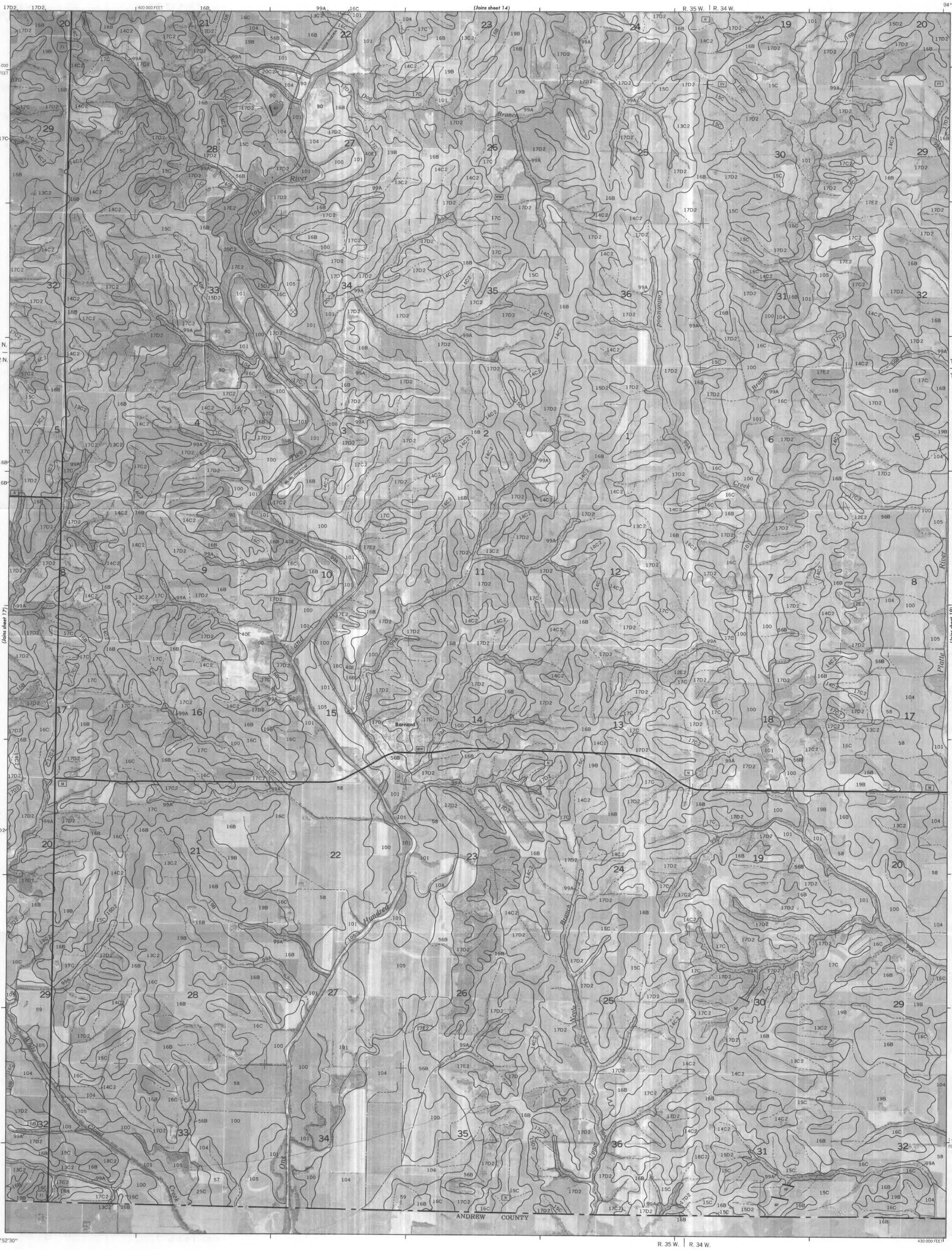

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1 ½ ¼ ⅛ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet

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1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10 000 Feet

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